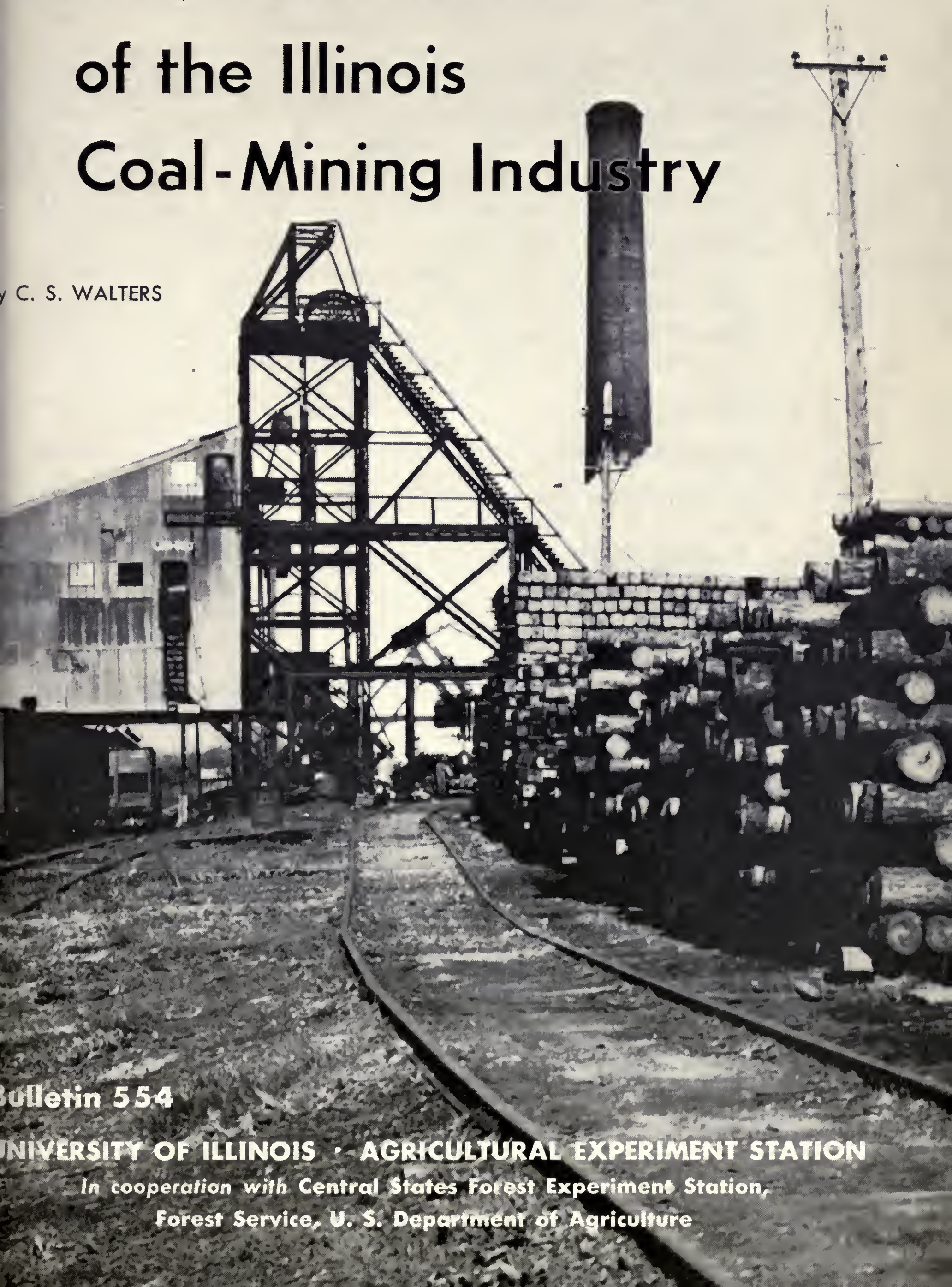
HARDWOOD REQUIREMENTS of the Illinois Coal-Mining Industry

By C. S. WALTERS



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HARDWOOD REQUIREMENTS
of the ILLINOIS COAL-MINING INDUSTRY

By C. S. Walters, Associate Professor of Forest Utilization

IT TAKES WOOD to mine coal in Illinois. The coal-mining industry requires wood in many forms, and to date no satisfactory, economical substitute for wood has been developed for many of these requirements. Most of the wood is used in underground mines to support the roofs of entryways made for extracting the coal or for transporting it aboveground. Wood is also used for mats to support the heavy shovels used in strip mines,[a] and it will probably continue to be used in this way for many years.

A number of reports include some data or estimates on the amount of wood used by Illinois coal mines during the first quarter of the twentieth century. In 1911 Hall and Ingalls[5*] reported that one-fifth cubic foot of wood was required to mine one ton of coal, with a total of about 10,736,000 cubic feet being used during the year. In 1915 Andros[1*] estimated that from 1.5 to 3 props (perhaps 0.75 to 1.5 cubic feet) were needed for mining one ton in "long wall mines" and from 2 to 12 props (perhaps 1 to 6 cubic feet) in mines using the "room and pillar" system of mining.

In 1924 Miller[12*] estimated the need as ". . . not far from 0.25 cubic feet of timber [for] one ton of coal, or 20,000,000 cubic feet for the whole state, not including lumber used for buildings and other construction purposes."

None of these early reports were based upon detailed studies of the coal-mining industry's requirements. Most of the estimates were based on the total annual drain on the forest resource by the mining industry. The wide variation in estimates was probably due to lack of sufficient information. Later estimates, such as those reported in *A Plan for Forestry in Illinois*[9*] and by Brundage and Crow in *Forest Resources of Illinois*,[2*] were based upon conversion factors prepared by the U. S. Forest Service for national reports or upon a partial sampling of the larger mines in studies on the drain of forest resources.

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[a] Strip (or open-cut) mines are so-called because the thin overburden of soil, slate, and rocks lying immediately on top of the layer of coal is stripped off with large power shovels. This method of getting the coal is more practical and economical for the operators in some areas than is underground mining.

* All superior figures with asterisk refer to literature citations on page 547.

PURPOSE AND METHODS OF STUDY

This study concerns the 1948 hardwood[a] requirements of the Illinois coal-mining industry. Thousands of board feet[b] of southern or western softwood lumber are also used in the mines or their surface structures, but, because Illinois woodlands now produce an insignificant volume of softwoods, no attempt has been made to determine their volume. Only a small volume of softwood products other than lumber was used in 1948, and it has been identified in the tables.

Objectives

The purpose of this study was to determine (1) the types and volumes of hardwood products used by the Illinois coal-mining industry, the sources of these products, and the channels through which they passed from producer to mine owner; (2) the drain on the Illinois forest resource created by the coal-mining industry and the relation between the annual growth and drain; (3) future timber requirements of the coal-mining industry and the possibility of supplying them from public and private woodlands; (4) the types and amount of wood products reclaimed and reused; (5) the possibility of utilizing treated wood of species not now being used because of their low resistance to decay and insects; (6) the possibility of standardizing the sizes of wood products used by the mines; and (7) the feasibility of establishing concentration yards through which the farmer or small producer could market his mine timbers.

Methods

Collection of data and sampling. The data on which this report is based were secured by interviewing the operators of 91 sample mines. The names of these mines were obtained from the 1947 Coal Report.[7*] Once the sample mines were identified, however, analysis of the data they contributed was based upon the 1948 Coal Report.[8*]

Of the 342 mines reported in 1948, 305 which produced at least 1,000 tons of coal were included in this study (Table 1). The mines

[a] Botanically, native species of trees are divided into two classes: hardwoods, which have broad leaves that are dropped each fall (elm, oak, cottonwood); and softwoods or conifers, which have leaves like needles or scales (spruce, pine, fir). No definite degree of hardness of the wood divides the hardwoods and softwoods. For example, southern pine, a softwood, is harder than cottonwood, a hardwood.

[b] A board foot is a unit of measure 1 inch thick, 12 inches wide, and 1 foot long.

Table 1. — Number of Mines[a] in Illinois, Classified According to Production and Type; and Number in Each Class Sampled for This Study

Mine class	Coal production, 1948 (tons)	Underground mines												Strip mines						All mines	
		Shipping								Local, all classes		Total shipping and local		Shipping		Local		Total			
		Shaft		Slope		Drift		Total													
		In Ill.	In sample	In Ill.	In sample	In Ill.	In sample	In Ill.	In sample	In Ill.	In sample	In Ill.	In sample	In Ill.	In sample	In Ill.	In sample	In Ill.	In sample	In Ill.	In sample
1	More than 1 000 000	12	10	0	0	0	0	12	10	0	0	12	10	7	5	0	0	7	5	19	15
1A	500 000 to 999 999	21	7	4	3	1	1	26	11	0	0	26	11	7	2	1	1	8	3	34	14
1B	200 000 to 499 999	9	2	4	1	1	1	14	4	0	0	14	4	6	1	1	1	7	2	21	6
2	100 000 to 199 999	10	2	7	1	0	0	17	3	1	0	18	3	4	2	0	0	4	2	22	5
3	50 000 to 99 999	8	1	2	1	0	0	10	2	10	5	20	7	9	2	1	1	10	3	30	10
4	10 000 to 49 999	14	4	14	0	0	0	28	4	59	15	87	19	9	3	5	1	14	4	101	23
5	1 000 to 9 999	1	0	6	2	0	0	7	2	57	12	64	14	3	0	11	4	14	4	78	18
	Total mines	**75**	**26**	**37**	**8**	**2**	**2**	**114**	**36**	**127**	**32**	**241**	**68**	**45**	**15**	**19**	**8**	**64**	**23**	**305**	**91**

[a] Producing a minimum of 1,000 tons of coal in 1948.

were grouped into "underground" and "strip." Each of these groups was further divided on the basis of production. The coal production classes shown in Table 1 conform with those developed by the U. S. Bureau of Mines except that the upper limit of the "1A" class was set at 999,999 tons and a new class of mines which produced at least 1,000,000 tons in 1947 (Class 1) was included.

The 91 mines supplying information were selected at random. They comprised 68 underground mines and 23 strip mines. With few exceptions, the sample included at least 25 percent of each production class for each type of mine. The sample mines were located in all sections of the state.

Among the underground mines, "local" mines (those selling most of the coal they produce to local outlets) outnumbered the "shipping" mines. Of the 241 underground mines included in the study, 127 were classified as local.[8*] Thirty-two of these were visited. Even though there were fewer shipping mines, these produce most of the coal mined each year. Therefore, 36 of the 114 were visited.

Among the strip mines, shipping mines outnumbered the local mines. Fifteen of the 45 shipping mines and 8 of the 19 local mines were visited.

The sample mines produced 53.4 percent of the total 1948 coal output of all mines included in the study (Table 2). Sample underground mines produced 38.6 percent of the state total, and sample strip mines, only 14.8 percent. However, the sample mines in each of the two groups produced about the same percentage of the total coal mined by that group. Sample underground mines produced 53.0 percent of the coal mined by all the underground mines in the state; and sample strip mines produced 54.7 percent of the coal mined by the strip mines.

Because the amount of wood used to produce a ton of coal varied with individual mines, weighted averages based on 1948 coal production figures were computed and are presented in the tables.

Most of the reports for 1948 represented a normal, or "average," year, and the "over" and "under" reports were in the minority. There is one minor exception, however, and it concerns the use of treated wood by Class 4 strip mines (page 527).

No attempt was made to analyze the requirements for underground mines on the basis of mining method or system of entry, since such details were not intended to be within the scope of this study.

The information on species requirements lacks some of the detail

Table 2. — 1948 Coal Production of All Illinois Mines[a] and of Sample Mines

Mine class	Number of mines		1948 coal production			
			All mines		Sample mines	
	In Ill.	In sample	Tons	Percent of total state production	Tons	Percent of total class production
Underground mines						
1	12	10	18 658 630	38.7	15 218 807	81.6
1A	26	11	18 255 755	37.8	7 484 773	41.0
1B	14	4	5 006 819	10.4	1 356 891	27.1
2	18	3	2 336 461	4.8	443 756	19.0
3	20	7	1 342 582	2.8	471 861	35.1
4	87	19	2 372 933	4.9	517 296	21.8
5	64	14	307 014	.6	83 498	27.2
Subtotal	241	68	48 280 194	100.0	25 576 882	53.0
Strip mines						
1	7	5	8 672 769	48.5	6 127 265	70.6
1A	8	3	5 567 388	31.2	2 413 397	43.3
1B	7	2	2 010 510	11.3	607 786	30.2
2	4	2	525 867	2.9	285 939	54.4
3	10	3	723 718	4.0	218 473	30.2
4	14	4	317 142	1.8	102 820	32.4
5	14	4	53 853	.3	14 890	27.6
Subtotal	64	23	17 871 247	100.0	9 770 570	54.7
Total	305	91	66 151 441	100.0	35 347 452	53.4

[a] Mines producing less than 1,000 tons in 1948 were not included.

that might be desirable; however, this information was not available in a form that permitted detailed analysis.

Actual records and estimates used. Most of the larger mines supplied data from detailed business records. Smaller mines, as a rule, estimated their requirements. To determine annual timber consumption, they multiplied daily requirements for the various kinds of products by number of days worked. Actual time records were used in these calculations. Although the estimated requirements may have been less accurate than those supplied from the detailed records, it is believed that the estimates are within the limits of error permitted in a study of this type.

Conversion factors. Conversion factors were used in calculating the various estimates. Early in the field work it became apparent that "tip diameter" of props, posts, and legs[a] had a different meaning for different operators. To most operators, it meant "minimum acceptable diameter," but to some it meant "average" size. For this study, the average tip diameter for a prop or post was determined and was used,

[a] A description of the various products is given on pages 506 to 525.

with an allowance for taper, to compute the average midpoint diameter. Most of the mines bought products of a specified length. This length was used with average midpoint diameter to calculate volume in cubic feet.

Over half of the bars purchased were squared on at least two sides. Therefore, the board foot unit was used in calculating the volume of bars. The volume for round bars was determined as though they had been squared. For example, an eight-foot round bar with a six-inch tip contained 10.6 board feet, or the same volume as a 4″x 4″- 8′.

The volume for wedges was based upon thickness at midpoint. For example, a 1″x 4″- 12″ wedge had a midpoint thickness of ½ inch (tapering from a 1-inch butt to 0 at the tip) and a volume of 0.17 board feet.

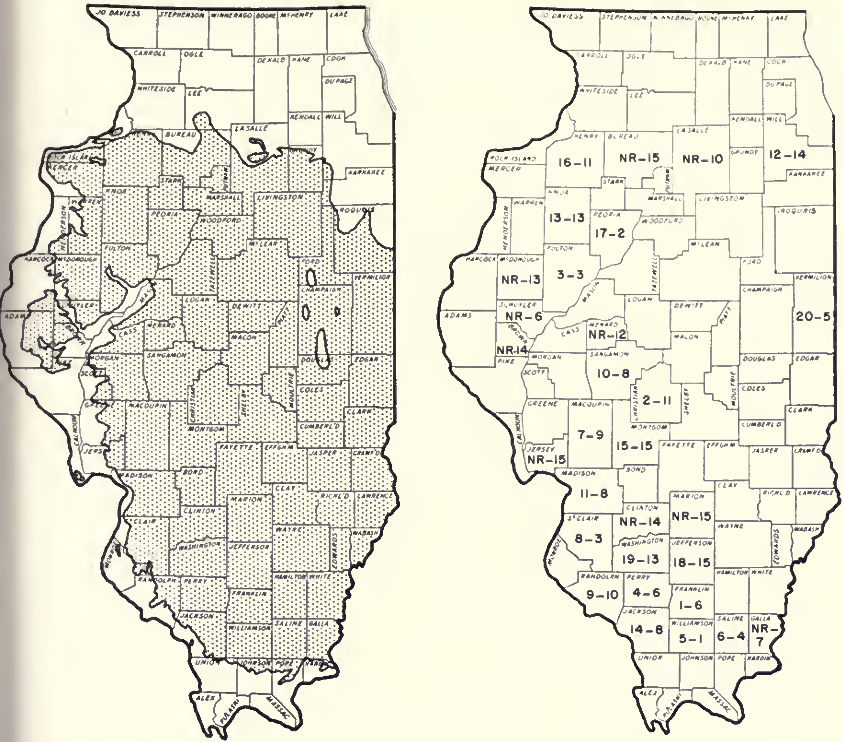
COAL PRODUCTION PAST AND PRESENT

Illinois is underlain with one of the richest deposits of coal in the entire world (Fig. 1). In 1948 Illinois ranked fourth in the United States in coal production.[13*] Although about three-quarters of the state is underlain with coal, only about half of the counties have mines that are extracting the coal on a commercial scale. Fig. 1 shows the leading counties ranked on the basis of 1948 coal production and number of mines operating. Geologists estimate our coal reserve at about 137 billion tons,[a] which, at the 1948 rate of mining, would furnish us fuel and power until the year 4018, or about 2,070 years.

Coal was first discovered in North America by Joliet and Marquette in 1673 in outcroppings in the Illinois river bluffs.[6*] It wasn't until 1810, however, that the first shipment of coal was made from an Illinois mine; and not until the 1830's that there was any large-scale production in the state.

The mining of coal encouraged the building of railroads. In fact, the first railroad in Illinois, completed in 1837, was a six-mile track across the "American Bottoms" from St. Louis to a river-bluff coal mine.[1*] The railroads in turn stimulated coal production (especially after coal-burning locomotives replaced the early "wood-burners"). As additional rail trackage was laid, coal production doubled and trebled. In 1833, 6,000 tons were mined; in 1841, 35,000 tons; in 1851, 320,000 tons; in 1861, 670,000 tons; and in 1871, 3,000,000 tons.[1*] The combination of cheap transportation and an abundance of coal encouraged industrial expansion.

[a] Figures supplied by Illinois State Geological Survey.



Coal measure in Illinois (*map on left*); and leading counties ranked on basis of 1948 coal production (first number) and number of mines operating in 1948 (second number). "NR" indicates county is not ranked. (Fig. 1)

Because many of the early miners depended upon local resources for their raw materials, there is little doubt that the first props, ties, and even railroad rails came from local forests. The use of wooden mine material undoubtedly increased with the increase in production.

WOOD CONSUMPTION AND VALUE

Total Figures

The volume, cost, source, and numbers of wood products used by the Illinois coal-mining industry in 1948 are shown in Tables 3 to 6.

A total of 40,985,400 bd. ft. of sawed products and 5,158,100 cu. ft. of other products was used by Illinois mines[a] in 1948 (Table 3). The

[a] Unless otherwise specified, "mine" hereafter refers to one which met the minimum production requirements of 1,000 tons in 1948.

grand total expressed only in board feet is 71,934,000.[a] However, estimating small, round products, such as props, in terms of board feet is believed to be unsound, because these items are rarely squared for use and it would be impractical and uneconomical to cut them into squared forms. The total in terms of cubic feet is 11,989,000.[a] Underground mines used 38,229,200 bd. ft. (93 percent) of the sawed products and all of the 5,158,100 cu. ft. of the round products.

Mine operators spent $3,282,300 (Table 4) for the products whose volumes are reported in Table 3. Of this amount, $2,120,660 (65 percent) was for sawed materials and $1,161,640 for other products. The sawed products averaged $52 per thousand board feet, and the other products 23 cents a cubic foot. Of the total money expended, underground mines spent $3,111,500 (95 percent).

In 1948 Illinois woodlands supplied nearly two-thirds (63 percent) of the total volume of wood used by her coal-mining industry. This included 28,263,260 bd. ft. (69 percent) of the sawed products and 2,875,210 cu. ft. (55.8 percent) of the round products used in Illinois mines. Indiana and Wisconsin supplied only small amounts (0.1 percent or less), and Missouri supplied the rest, although some of the sample mines were located in counties bordering or within trucking distance of Kentucky.

The percentage of wood supplied by Illinois forests in 1948 was higher than during the war. It was estimated that in the war years Missouri supplied more than half of the mine timber used in Illinois. With woods labor scarce, mine operators were forced to depend upon carload shipments of Missouri timbers rather than truckload deliveries from local woodlands.

Table 6 lists the number of piece products used. Only those items that are commonly purchased by the piece are included. Lumber, for example, is usually purchased by the thousand board feet and not by the piece, and for this reason it has been excluded from the table.

Products Used

Following are descriptions of the hardwood products used by Illinois coal mines in 1948; the volume and numbers used; the species required for each product; prices paid; and the source of supply. As already mentioned, volume, cost, source, and numbers of products are summarized in Tables 3 through 6.

[a] Conversion factor used was: 6 bd. ft. = 1 cu. ft.

Table 3. — Volume of Hardwood[a] Consumed by Illinois Coal Mines[b] in 1948

Mine class	Cross-ties	Bars	Wedges	Lumber	Caps and header-blocks	Timbers	Misc. sawed products[c]	Props	Posts, legs	Scotch blocks and sprags	Total all sawed products	Other products
Underground mines												
	bd. ft.	*bd. ft.*	*bd. ft.*	*bd. ft.*	*bd. ft.*	*bd. ft.*	*bd. ft.*	*cu. ft.*	*cu. ft.*	*cu. ft.*	*bd. ft.*	*cu. ft.*
1	5 616 200	2 276 400	2 668 200	1 586 000	1 847 200	(d)	189 700	1 959 200	410 500	1 200	14 183 700	2 370 900
1A	5 878 400	4 509 200	2 811 400	712 000	894 500	...	...	1 241 400[a]	63 900	700	14 805 500	1 306 000
1B	1 001 400	440 600	210 300	240 300	395 500	...	...	465 600	19 300	...	2 288 100	484 900
2	546 700	448 600	51 400	116 800	3 300	...	...	184 600	...	...	1 166 800	184 600
3	541 100	73 800	28 200	81 900	85 900	...	...	300 700	...	...	810 900	300 700
4	2 857 000	268 100	61 700	626 500	83 100	329 800	...	431 900	9 700	...	4 226 200	441 600
5	598 100	17 800	11 100	99 200	13 500	8 300	...	65 400	4 000	...	748 000	69 400
Subtotal	17 038 900	8 034 500	5 842 300	3 462 700	3 323 000	338 100	189 700	4 648 800	507 400	1 900	38 229 200	5 158 100
Strip mines												
1	98 000	...	...	112 700	...	494 300	21 700	...	...	...	726 700	...
1A	111 300	...	...	13 900	...	406 400	...	...	...	...	531 600	...
1B	404 100	...	...	144 800	...	170 900	...	...	...	...	719 800	...
2	...	...	...	...	...	...	42 600	...	...	...	42 600	...
3	4 600	...	...	12 300	...	...	...	...	...	...	16 900	...
4	412 600	...	...	62 200	...	...	...	...	...	...	474 800	...
5	79 100	...	...	103 100	...	61 600	...	...	...	...	243 800	...
Subtotal	1 109 700	...	...	449 000	...	1 133 200	64 300	...	...	...	2 756 200	...
Total	**18 148 600**	**8 034 500**	**5 842 300**	**3 911 700**	**3 323 000**	**1 471 300**	**254 000**	**4 648 800**	**507 400**	**1 900**	**40 985 400**[e]	**5 158 100**[e]

[a] Includes 6,220 cu. ft. (0.1 percent) tamarack from Wisconsin.
[b] Mines producing less than 1,000 tons in 1948 were not included.
[c] Lagging, machine blocks, shim boards, and car patching.
[d] Blanks signify that none of the mines questioned in the specified class reported that they used any wood for the purpose indicated.
[e] Grand totals in terms of board feet and cubic feet are given on page 506.

Table 4. — Cost of Hardwood Products[a] Consumed by Illinois Coal Mines[b] in 1948

Mine class	Crossties		Bars		Wedges		Lumber		Caps and headerblocks		Timbers	
	Per ton of coal	Total	Per ton of coal	Total	Per ton of coal	Total	Per ton of coal	Total	Per ton of coal	Total	Per ton of coal	Total
Underground mines												
1	$.0146	$272 420	$.0055	$102 620	$.0098	$182 860	$.0058	$108 220	$.00490	$91 430	(c)	$.....
1A	.0159	290 270	.0096	175 250	.0129	235 500	.0023	41 990	.00170	31 030	$.....	......
1B	.0120	60 080	.0051	25 530	.0004	2 000	.0040	20 030	.00180	9 010	.....	......
2	.0094	21 960	.0116	27 100	.0012	2 800	.0035	8 180	.00003	60	.....	......
3	.0129	17 320	.0021	2 820	.0013	1 750	.0049	6 580	.00380	5 100	.....	......
4	.0427	101 320	.0074	17 560	.0019	4 510	.0170	40 340	.00150	3 560	.0034	8 070
5	.0402	12 340	.0021	640	.0035	1 070	.0137	4 210	.00570	1 750	.0027	830
Subtotal	$.0161	$775 710	$.0073	$351 520	$.0089	$430 490	$.0047	$229 550	$.00294	$141 940	$.0002	$8 900
Strip mines												
1	.0008	6 940	.....	......	.....	......	.0016	13 880	......	......	.0024	20 810
1A	.0014	7 790	.....	......	.....	......	.0003	1 670	......	......	.0054	30 060
1B	.0127	25 530	.....	......	.....	......	.0043	8 640	......	......	.0014	8 850
2	.....	......	.....	......	.....	......	.....	......	......	......	.....	......
3	.0002	180	.....	......	.....	......	.0010	720	......	......	.....	......
4	.0954	30 250	.....	......	.....	......	.0020	630	......	......	.....	......
5	.0881	4 740	.....	......	.....	......	.1252	6 740	......	......	.0368	1 980
Subtotal	$.0039	$ 75 430	.....	......	.....	......	$.0011	$ 32 280	......	......	$.0024	$61 700
Total	**$.0128**	**$851 140**	**$.0053**	**$351 520**	**$.0065**	**$430 490**	**$.0039**	**$261 830**	**$.00215**	**$141 940**	**$.0008**	**$70 600**

(For footnotes see page 509.)

Table 4. — Concluded

Mine class	Miscellaneous sawed products: Per ton of coal	Miscellaneous sawed products: Total	Props: Per ton of coal	Props: Total	Posts, legs: Per ton of coal	Posts, legs: Total	Scotch blocks and sprags: Per ton of coal	Scotch blocks and sprags: Total	All products: Per ton of coal	All products: Total
Underground mines										
1	$.000629	$11 750	$.0242	$ 451 540	$.00594	$110 080	$.000005	$ 100	$.0713	$1 331 020
1A	.....	.....	.0158	288 440	.00059	10 770	.000130	2 370	.0589	1 075 620
1B	.....	.....	.0204	102 140	.00110	5 510	.....	.....	.0448	224 300
2	.....	.....	.0151	35 280	.....	.....	.....	.....	.0408	95 380
3	.....	.....	.0371	49 810	.....	.....	.....	.....	.0621	83 380
4	.....	.....	.0387	91 830	.00081	1 920	.....	.....	.1134	269 110
5	.....	.....	.0354	10 870	.00319	980	.....	.....	.1065	32 690
Subtotal	$.000243	$11 750	$.0213	$1 029 910	$.00268	$129 260	$.000051	$2 470	$.0644	$3 111 500
Strip mines										
1	$.000054	$ 470	.....	.....	.....	.....	.....	.....	$.0049	$ 42 100
1A	.....	.....	.....	.....	.....	.....	.....	.....	.0071	39 520
1B	.....	.....	.....	.....	.....	.....	.....	.....	.0214	43 020
2	.001749	920	.....	.....	.....	.....	.....	.....	.0005	920
3	.....	.....	.....	.....	.....	.....	.....	.....	.0012	900
4	.....	.....	.....	.....	.....	.....	.....	.....	.0974	30 880
5	.....	.....	.....	.....	.....	.....	.....	.....	.2500	13 460
Subtotal	$.000078	$ 1 390	.....	.....	.....	.....	.....	.....	$.0096	$ 170 800
Total	**$.000199**	**$13 140**	**$.0156**	**$1 029 910**	**$.00195**	**$129 260**	**$.000037**	**$2 470**	**$.0496**	**$3 282 300**

[a] Includes cost of 6,220 cu. ft. of tamarack.
[b] Mines producing less than 1,000 tons in 1948 were not included.
[c] Blanks signify that none of the mines questioned in the specified class reported that they used any wood for the purpose indicated.

Table 5. — Source of Hardwood Products[a] Used by Illinois Coal Mines[b] in 1948

Product	Total volume used in 1948	ILLINOIS							
		Class 1		Class 1A		Class 1B		Class 2	
		Volume	Pct.	Volume	Pct.	Volume	Pct.	Volume	Pct.
Underground mines									
	bd. ft.	*bd. ft.*		*bd. ft.*		*bd. ft.*		*bd. ft.*	
Crossties	17 038 900	1 235 560	7.3	2 233 790	13.1	861 200	5.1	344 420	2.0
Bars	8 034 500	1 593 480	19.8	3 201 530	39.8	312 830	3.9	381 310	4.8
Wedges	5 842 300	2 668 200	45.6	2 389 690	40.9	210 300	3.6	51 400	0.9
Lumber	3 462 700	1 189 500	34.3	662 160	19.1	240 300	6.9	116 800	3.4
Caps and headerblocks	3 323 000	1 200 680	36.1	769 270	23.1	395 500	11.9	3 300	.1
Timbers	338 100	(c)	....	....	....	....	...	....	....
Machine blocks	143 100	143 100	100.0	....	....	....	...	....	....
Lagging	46 600	46 600	100.0	....	....	....	...	....	....
Subtotal	38 229 200	8 077 120	21.1	9 256 440	24.2	2 020 130	5.3	897 230	2.3
	cu. ft.	*cu. ft.*		*cu. ft.*		*cu. ft.*		*cu. ft.*	
Props	4 648 800	764 090	16.4	531 310	11.4	465 600	10.0	140 300	3.0
Posts, legs	507 400	184 720	36.4	46 010	9.1	18 530	3.7	....	....
Sprags and Scotch blocks	1 900	1 200	63.2	700	36.8	....	...	....	....
Subtotal	5 158 100	950 010	18.4	578 020	11.2	484 130	9.4	140 300	2.7
Strip mines									
	bd. ft.	*bd. ft.*		*bd. ft.*		*bd. ft.*		*bd. ft.*	
Timbers	1 133 200	494 300	43.6	406 400	35.9	170 900	15.1	....	....
Crossties	1 109 700	98 000	8.9	111 300	10.0	404 100	36.4	....	....
Lumber	449 000	112 700	25.1	13 900	3.1	144 800	32.2	....	....
Car patching	42 600	....	....	....	....	....	...	42 600	100.0
Shim boards	21 700	21 700	100.0	....	....	....	...	....	....
Subtotal	2 756 200	726 700	26.4	531 600	19.3	719 800	26.1	42 600	1.6
Total bd. ft.	**40 985 400**	**8 803 820**	**21.5**	**9 788 040**	**23.9**	**2 739 930**	**6.7**	**939 830**	**2.3**
Total cu. ft.	**5 158 100**	**950 010**	**18.4**	**578 020**	**11.2**	**484 130**	**9.4**	**140 300**	**2.7**

Product	Class 3		Class 4		Class 5		Total, all classes	
	Volume	Pct.	Volume	Pct.	Volume	Pct.	Volume	Pct.
Underground mines								
	bd. ft.		*bd. ft.*		*bd. ft.*		*bd. ft.*	
Crossties	449 110	2.6	2 542 730	14.9	562 210	3.3	8 229 020	48.3
Bars	60 520	.8	254 700	3.2	1 250	T[d]	5 805 620	72.3
Wedges	28 200	.5	50 590	.9	7 660	.1	5 406 040	92.5
Lumber	78 620	2.3	626 500	18.1	97 220	2.8	3 011 100	86.9
Caps and headerblocks	64 420	2.0	83 100	2.5	11 210	.4	2 527 480	76.1
Timbers	....	....	329 800	97.5	8 300	2.5	338 100	100.0
Machine blocks	....	....	....	....	....	...	143 100	100.0
Lagging	....	....	....	....	....	...	46 600	100.0
Subtotal	680 870	1.8	3 887 420	10.3	687 850	1.8	25 507 060	66.8
	cu. ft.		*cu. ft.*		*cu. ft.*		*cu. ft.*	
Props	297 690	6.6	362 800	7.9	50 360	1.1	2 612 150	56.4
Posts, legs	....	....	9 700	1.9	2 200	.4	261 160	51.5
Sprags and Scotch blocks	....	....	....	....	....	...	1 900	100.0
Subtotal	297 690	5.8	372 500	7.3	52 560	1.0	2 875 210	55.8
Strip mines								
	bd. ft.		*bd. ft.*		*bd. ft.*		*bd. ft.*	
Timbers	....	....	....	....	61 600	5.4	1 133 200	100.0
Crossties	4 600	.4	412 600	37.2	79 100	7.1	1 109 700	100.0
Lumber	12 300	2.7	62 200	13.9	103 100	23.0	449 000	100.0
Car patching	....	....	....	....	....	...	42 600	100.0
Shim boards	....	....	....	....	....	...	21 700	100.0
Subtotal	16 900	.6	474 800	17.2	243 800	8.8	2 756 200	100.0
Total bd. ft.	**697 770**	**1.7**	**4 362 220**	**10.6**	**931 650**	**2.3**	**28 263 260**	**69.0**
Total cu. ft.	**297 690**	**5.8**	**372 500**	**7.3**	**52 560**	**1.0**	**2 875 210**	**55.8**

(For footnotes see page 511.)

Table 5. — Concluded

Product[e]	MISSOURI							
	Class 1		Class 1A		Class 1B		Class 2	
	Volume	Pct.	Volume	Pct.	Volume	Pct.	Volume	Pct.
Underground mines								
	bd. ft.		*bd. ft.*		*bd. ft.*		*bd. ft.*	
Crossties	4 380 640	25.7	3 644 610	21.4	140 200	.8	202 280	1.2
Bars	682 920	8.5	1 307 670	16.2	127 770	1.6	67 290	.8
Wedges	....	....	421 710	7.2	....	...	....	....
Lumber	396 500	11.5	49 840	1.4	....	...	....	....
Caps and headerblocks	646 520	19.4	125 230	3.8	....	...	....	....
Total bd. ft.	6 106 580	15.9	5 549 060	14.5	267 970	.7	269 570	.7
	cu. ft.		*cu. ft.*		*cu. ft.*		*cu. ft.*	
Props	1 195 110	25.6	703 870	15.1	....	...	44 300	.9
Posts, legs	225 780	44.5	17 890	3.5	770	.2	....	....
Total cu. ft.	1 420 890	27.5	721 760	14.0	770	T[d]	44 300	.9

Product[e]	Class 3		Class 4		Class 5		Total, all classes	
	Volume	Pct.	Volume	Pct.	Volume	Pct.	Volume	Pct.
Underground mines								
	bd. ft.		*bd. ft.*		*bd. ft.*		*bd. ft.*	
Crossties	91 990	.6	314 270	1.8	35 890	.2	8 809 880	51.7
Bars	13 280	.2	13 400	.2	....	...	2 212 330	27.5
Wedges	....	....	11 110	.2	....	...	432 820	7.4
Lumber	3 280	.1	....	....	....	...	449 620	13.0
Caps and headerblocks	....	....	....	....	....	...	771 750	23.2
Total bd. ft.	108 550	.3	338 780	.9	35 890	.1	12 676 400	33.1
	cu. ft.		*cu. ft.*		*cu. ft.*		*cu. ft.*	
Props	3 010	.1	69 100	1.5	15 040	.3	2 030 430	43.5
Posts, legs	....	....	....	....	....	...	244 440	48.2
Total cu. ft.	3 010	.1	69 100	1.3	15 040	.3	2 274 870	44.1

Product[e]	INDIANA						WISCONSIN	
	Class 3		Class 5		Total, all classes[f]		Class 1A[g]	
	Volume	Pct.	Volume	Pct.	Volume	Pct.	Volume	Pct.
Underground mines								
	bd. ft.		*bd. ft.*		*bd. ft.*			
Bars	....	....	16 550	.2	16 550	.2	....	....
Wedges	....	....	3 440	.1	3 440	.1	....	....
Lumber	....	....	1 980	.1	1 980	1	....	....
Caps and headerblocks	21 480	.6	2 290	.1	23 770	.7	....	....
Total bd. ft.	21 480	.1	24 260	.1	45 740	.1	....	....
	cu. ft.		*cu. ft.*		*cu. ft.*		*cu. ft.*	
Props	....	....	....	....	....	...	6 220[a]	.1
Posts, legs	....	....	1 800	.3	1 800	.3	....	....
Total cu. ft.	....	....	1 800	T[d]	1 800	T[d]	6 220	.1

No strip mines reported purchases of wood outside Illinois.

[a] Includes 6,220 cu. ft. of tamarack from Wisconsin.
[b] Mines producing less than 1,000 tons in 1948 were not included.
[c] Blanks signify that none of the mines questioned in the specified class reported that they used any wood for the purpose indicated.
[d] T = trace, less than 0.1 percent.
[e] Some of the products included on page 510 are not listed, because none of the mines reported buying any outside Illinois.
[f] Class 3 and Class 5 mines were the only ones reporting purchases in Indiana.
[g] Class 1A mines were the only ones reporting purchases in Wisconsin.

Table 6. — Numbers of Hardwood Piece Products Used by Illinois Coal Mines[a] in 1948

Mine class	Cross-ties	Bars	Wedges	Caps and header-blocks	Timbers	Machine blocks	Lagging	Props	Posts, legs	Scotch blocks and sprags
Underground mines										
1	410 490	55 970	11 568 350	2 593 550	(b)	93 290	7 840	1 100 860	223 900	6 900
1A	474 650	171 600	14 823 670	711 970	.....	......	.....	785 000	21 910	9 130
1B	185 250	20 030	856 170	806 100	.....	......	.....	635 870	15 020	......
2	100 470	11 680	242 990	7 010	.....	......	.....	116 820	......	......
3	3 990	120	7 000	17 690	.....	......	.....	12 510	......	......
4	562 390	11 860	327 460	315 600	9 490	......	.....	460 350	9 490	......
5	87 810	2 460	60 790	59 560	90	......	.....	71 530	3 380	......
Subtotal	1 825 050	273 720	27 886 430	4 511 480	9 580	93 290	7 840	3 182 940	273 700	16 030
Strip mines										
1	5 200	......	....	....	1 730	......	.....	....	......	......
1A	2 230	......	....	....	840	......	.....	....	......	......
1B	12 060	......	....	....	400	......	.....	....	......	......
2	....	......	....	....	.....	......	.....	....	......	......
3	150	......	....	....	.....	......	.....	....	......	......
4	11 730	......	....	....	.....	......	.....	....	......	......
5	1 830	......	....	....	1 080	......	.....	....	......	......
Subtotal	33 200	......	....	....	4 050	......	.....	....	......	......
Total	**1 858 250**	**273 720**	**27 886 430**	**4 511 480**	**13 630**	**93 290**	**7 840**	**3 182 940**	**273 700**	**16 030**

[a] Mines producing less than 1,000 tons in 1948 were not included.
[b] Blanks signify that none of the mines questioned in the specified class reported that they used any wood for the purpose indicated.

White oak and red elm roomties (*above*), 3″ x 5″ in cross-section. Note that waney (bark) edges and incipient decay have been accepted in these ties. Of the two standing ties, the one on the left is white oak and the one on the right is red elm. (Fig. 2)

Oak motorties pressure-treated with coal tar creosote (*right*). Dimensions are 6″x 8″- 8′. (Fig. 3)

Crossties. Most underground mines purchased crossties as "roomties" (Fig. 2) or "motorties" (Fig. 3). Roomties are smaller than motorties and are usually placed in temporary trackage. Strip mines generally used standard-gauge railroad crossties.

Over 40 different sizes of ties were reported in use by the sample mines. The range was from 3″x 3″- 4′ to 7″x 9″- 11½′ switch ties. Roomties were generally about 3″x 5″- 4½′ and motorties 6″x 8″- 6′, which is about the same size as a standard Class 3 railroad crosstie. Most of the ties were square-sawn, although some of the smaller

White oak mine ties (3"x 4"- 4½') cut from small, round pieces and hewn flat on two sides for use in one of the small, underground mines. Although the heartwood of white oak is resistant to decay, these ties are mainly of sapwood, which decays in a relatively short time. (Fig. 4)

mines bought roomties which were simply hewn flat on two sides (Fig. 4). At least one mine — a small one — reported using "split" ties (Fig. 5).

An estimated 18,148,600 bd. ft. was used for ties, most of which was oak. Total number of ties used was 1,858,250. Underground mines used 94 percent of the board feet and 98 percent of the ties.

Mine operators paid from 11 cents to $3.04 each for the ties, or an average of about 46 cents. Underground mines paid an average of 42 cents each, and strip mines, $2.27. The difference is due to the fact that, since strip-mine ties are usually for permanent spur trackage, they are larger and are treated with preservative chemicals. Although the average price paid by underground mines includes the cost of ties of similar specifications, the large number of small, untreated roomties weights the average price heavily. The difference in the average cost of ties bought by underground and by strip mines is reflected in the fact that underground mines spent only 91 percent ($775,710) of the total $851,140, even though they used 98 percent of the ties.

Less than half of the crossties were reported as coming from Illinois woodlands. Missouri was reported as supplying the rest. However, many of the mine operators reported Missouri as the source of their

These crossties were split from round bolts about 4 feet long. Only one mine reported using this type of tie. (Fig. 5)

crossties because the suppliers maintained offices in St. Louis. This was particularly true when treated ties were purchased. Some of the ties supplied by St. Louis firms were cut and treated in Illinois (as well as other states). Therefore, the figure given for Illinois is a conservative one.

Bars. The horizontal pieces placed next to the roof and supported on two posts or legs are called bars (Fig. 6). (Some mines used steel

Oak mine bars "slabbed" on two sides, stored according to length. These bars are 14 feet long. (Fig. 6)

railroad rails in place of wooden bars.) Bars were usually square-sawn on at least two sides. A few operators specified that one side be surfaced, and several specified "four sides square." Length ranged from 6½ feet to 20 feet, and thickness from 2 to 20 inches. Most of the bars were at least 5 inches thick.

A total of 8,034,500 bd. ft. (273,720 pieces) was used. Most of this was white oak. The bars cost the operators from 20 cents to $4.49 each. The wide range in price was probably due to regional variations in the supply of timber from which the producers could cut the larger sizes. In some areas "hardwood" 18-foot bars cost $1.80 each; in another area smaller white oak bars cost more than twice as much. The average was about $1.28, and the total about $351,520.

About three-fourths of the volume used was supplied by Illinois woodlands, with Missouri and Indiana supplying 27.5 percent and 0.2 percent respectively.

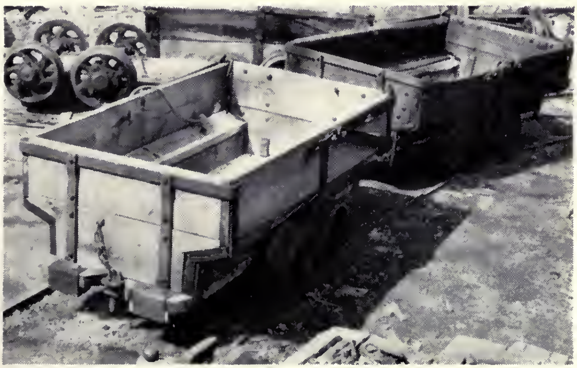
Wedges. Wedges (Fig. 7) were placed between the prop and the mine roof for support and for holding the prop in place. They were also sometimes used for miscellaneous purposes, such as leveling tracks. They were usually 1½ to 2 inches thick at the butt end and tapered to about $^3/_{16}$ inch or less at the tip. They probably averaged 4 inches in width and 10 or 12 inches in length.

Wedges about 4 inches wide, 12 to 16 inches long, and about 2 inches thick at the butt. Some wedges are only 1 inch thick at the butt. (Fig. 7)

Underground mines bought 27,886,430 wedges at an estimated cost of $430,490, or about 1½ cents each. The price ranged from $10 to $40 per 1,000 pieces. Apparently size had little effect on the cost, for the larger sizes were often cheaper than the smaller ones. For example, one-inch wedges 4 inches wide and 10 inches long were reported to have about the same price range as that given for all wedges. Since wedges were usually made of mill scraps, the cost to the producer was mostly for labor.

Illinois woodlands supplied 5,406,040 bd. ft. (92.5 percent) of wedges; Missouri, 432,820 (7.4 percent); and Indiana, 3,440 (0.1 percent).

Lumber.[a] This was purchased in a variety of sizes and for a variety of uses. Although much of it was purchased by the thousand board feet, some was bought by the piece, with size specified for a particular use.



White oak lumber was used in these mine cars because of its strength and resistance to decay. (Fig. 8)

Some of the lumber was used for aboveground buildings or parts of them, brattices,[b] air-control doors and shafts, scale platforms, and general repairs. Structural and shaft lumber was usually mixed species of oak of heavy sizes. Some one-inch lumber was used for brattices and miscellaneous purposes.

Most of the car lumber was purchased for the sides and bottoms of the cars used to transport coal from the coal seam to the tipple (Fig. 8). It was 1½ to 3 inches thick, 8 to 12 inches wide, and 9 feet or more long. Most of the car lumber was oak (much of it white oak), although some elm was used.

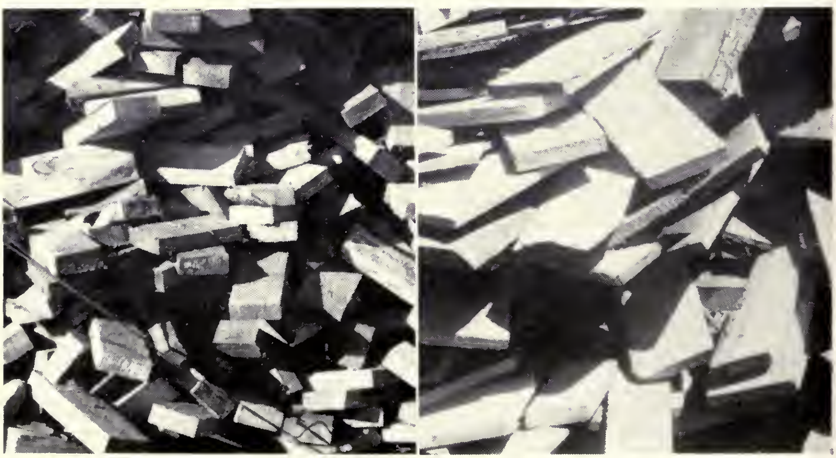
[a] Lumber hereafter refers to hardwood species unless otherwise specified.
[b] A brattice is a separating wall in a shaft or gallery to control air flow.

Of the 3,911,700 bd. ft. used, 88 percent (3,462,700 bd. ft.) was bought by underground mines. These mines spent $229,550 (88 percent) of the estimated total of $261,830. Prices ranged from $50 to $120, averaging about $59 per thousand board feet. Mixed species of oak lumber cost $55 to $75 per thousand board feet, and white oak ranged from $90 to $120.

Nearly 90 percent, or 3,011,100 bd. ft., of the lumber came from Illinois woodlands. Missouri supplied most of the rest, with a very little (0.1 percent) coming from Indiana.

Although detailed data on the consumption of softwood lumber were not secured, it is estimated that 5 to 10 million board feet of southern and western lumber was bought for brattices, air-control shafts, or construction and repair of surface buildings. In addition, several of the larger mines bought Brykett lath, a softwood planing mill product molded with V-workings or grooves to hold plaster and used as brattice.

Capboards and headerblocks. Like wedges, capboards and headerblocks were used for tightening the prop in place, as well as for leveling tracks and other miscellaneous purposes. Capboards were usually made of one-inch lumber about 4″x 10″ in size (Fig. 9). Headerblocks were larger, perhaps 3″x 6″- 2′ or 2″x 4″- 2′. The larger mines used more of the headerblocks and fewer of the capboards. All



Capboards of miscellaneous hardwoods. Those on left are 2″ x 4″ and 12 to 16 inches long. Most capboards, however, are of one-inch lumber like those shown on the right. (Fig. 9)

capboards and headerblocks were used in underground mines, since there is no overburden to be supported in strip mines.

About 3,323,000 bd. ft. of lumber was used for capboards and headerblocks. Most of these pieces were oak; but, because they were made from slabs, edging, and other mill waste, all species cut by local sawmills were used.

Most of the capboards were purchased by the piece (or 1,000 pieces), but a few mines bought them by weight. Perhaps unit of weight is a better sales measure than buying by the piece, for a truck-load delivery is rarely counted. Some of the headerblocks were bought by the thousand board feet.

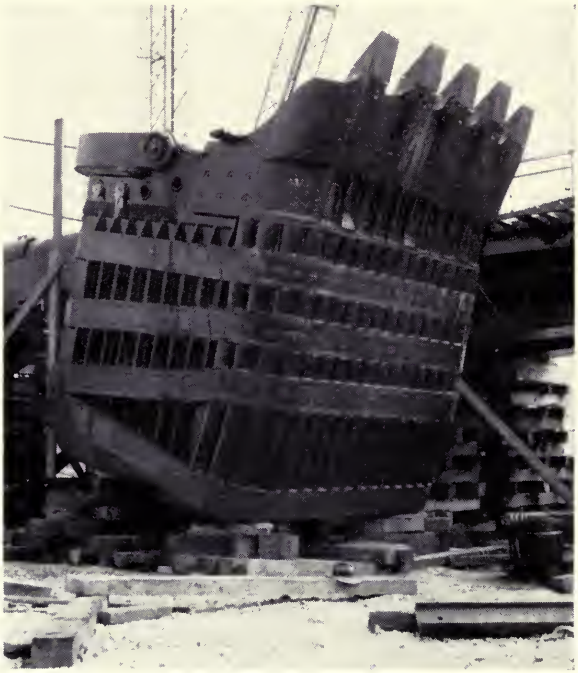
A total of 4,511,480 pieces cost $141,940, or about 3 cents each. Prices ranged from $10 to $22 per 1,000 pieces for capboards and from 4½ to 30 cents each for headerblocks. When headerblocks were bought by the thousand board feet, price ranged from $32 to $57.

About three-fourths (2,527,480 bd. ft.) of the total volume used came from Illinois woodlands. Missouri supplied 771,750 bd. ft. (23.2 percent) and Indiana 23,770 (0.7 percent).

Timbers. To be classified as a timber, a product had to be square and 5″x 5″ or larger in cross-section. There was some overlapping between bars and timbers in size. However, if a piece was used as a bar, it was so classified, even though it was of timber size.

Machine mat formed of timbers 16″x 16″- 20′ cut from white elm, black oak, and white oak. Although these timbers are used in places where they are subject to decay, they are not treated because they usually fail from mechanical wear first. (Fig. 10)

Strip mines bought the larger sizes (about 16″x 16″- 20′) for "mat timbers," lacing several together to form a mat or base upon which the heavy earth-moving equipment operated (Fig. 10). Occasionally they bought smaller sizes for other purposes (Fig. 11). Underground mines used timbers for a variety of purposes. Timbers bought by the underground mines rarely exceeded 8″x 8″ in cross-section and 12 feet

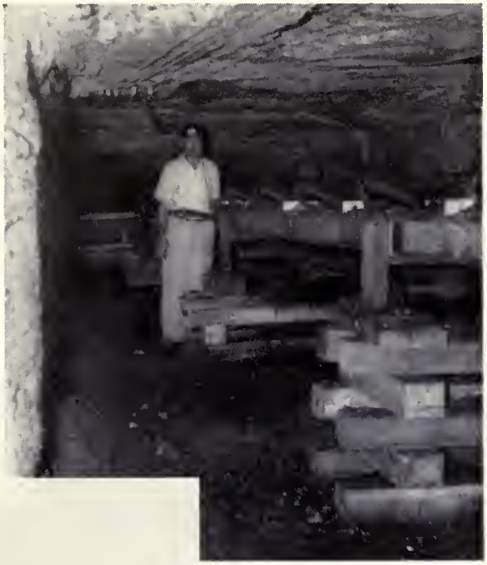


Shown in background and in foreground are some of the 6″x 8″ timbers needed to assemble the various parts of this huge earth-moving machine for an Illinois strip mine. (Fig. 11)

in length, although a few longer lengths were required for tipples or other large structures (Fig. 13). A few used crossties (6″x 8″- 8′) were placed in service as timbers and mats by both underground and strip mines (Fig. 14).

Oak was usually specified for the smaller timbers and "hardwood" for the mat timbers. Most of the timbers were oak or elm.

Of the 1,471,300 bd. ft. used by all mines, 77 percent was used by strip mines (Table 3). It is estimated that these mines accounted for $61,700 of the $70,600 spent for timbers, while underground mines spent only $8,900. Because strip mines bought the larger sizes, their average cost per timber was much higher than the average for the underground mines — approximately $15 as compared with a little less than $1.00. Many of the timbers were bought on a board-foot



These oak cribbing timbers support a 36-inch conveyor belt which aids in delivering coal from the mine to the rail car. The timbers were treated with chromated zinc chloride as protection against decay. (Fig. 12)

About 25,000 board feet of timbers and heavy lumber were required to build this mine tipple. (Fig. 13)

These used railroad ties were salvaged for use as a mat in a small strip mine. Note steel cable lacing them together. (Fig. 14)

scale, averaging about 280 bd. ft. per timber (a 12″x 14″- 20′ timber has a volume of 280 bd. ft.) and $55 per thousand board feet.

Illinois woodlands supplied all of the 13,630 timbers used by both underground and strip mines.

Lagging. In earlier days small round poles were used as lagging in Illinois mines (that is, to hold back the loose rocks in a roof or wall of an underground mine). But although plentiful, these poles

(*Top*) Oak lagging boards (1½″x 7″- 5′6″) are held in place by roof bolts. The boards have been treated with chromated zinc chloride. (*Below*) Close-up view of roof bolt, with oak plate block and expansion shield. The plate block serves the same purpose as lagging boards. (Fig. 15)

rotted quickly. In 1948 chemically treated squared material 1½ to 3 inches thick, 5 to 7 inches wide, and 5 feet or more long was used for lagging in more or less permanent installations. In some of the mines lagging was held in place with roof bolts (Fig. 15). Generally, however, the earth strata in Illinois mines do not require the use of lagging. Even those mines reporting its purchase and use did not use it widely.

Estimates showed that only 46,600 bd. ft. of lumber (7,840 pieces) was used for lagging by underground mines. All of it was oak. It is possible that some of the lumber purchased for this use may have been reported as construction lumber.

Lagging was usually bought by the piece in treated condition at an average of about $68 per thousand board feet or 40 cents for a piece containing 6 bd. ft. (2″x 6″- 6′ contains 6 bd. ft.). Piece price ranged from 32 to 40 cents. Total cost was $3,170. All lagging came from Illinois woodlands.

Machine blocks. These were used as supports, "chocks," or shims for various types of coal-mining machinery. Their use was reported only by the larger underground mines. Average size was about 3″x 4″-18″. The blocks were bought by the piece, an estimated 93,290 pieces (143,100 bd. ft.) being used. Oak was usually specified. The blocks cost $8,580, or about 9 cents apiece. All were cut from Illinois lumber.

Shim boards. The larger strip mines used shim boards for leveling crossties in temporary trackage and for leveling tie cribs (square stacks of ties used as supports or piers) in construction work. They were 2″x 8″- 18″. Cost was $14 a ton; the 21,700 bd. ft. that were used cost $470. Shim boards were made of oak and cut from Illinois timberlands.

Car patching. Class 2 strip mines bought car patching to repair holes in railroad cars before they were loaded with coal. This product was 1 to 2 inches thick, 12 to 24 inches wide, and 2 to 3 feet long. It cost $14 a ton. An estimated $920 was paid for 42,600 bd. ft. Car patching was cut from miscellaneous hardwoods, all of which came from Illinois woodlands.

Props. These are small timbers, either split or round (Fig. 16). They are used to support the roof in temporary openings in underground mines.

Length ranged from 3 feet 10 inches to 10 feet, and tip diameter from 3 inches to 8 inches. About 40 different length and diameter combinations were used.

These props will be used in underground mines. Shown above are short props (4½ feet long), which have been split from rather large white and black oak trees. Most of the round props shown at left were cut from a single sapling. They are about 7 feet long. (Fig. 16)

A total of 4,648,800 cu. ft. of props was used. Less than 1 percent was tamarack (a softwood), and the rest was hardwood species native to Illinois. Nearly 90 percent of the props were oak.

The mine operators paid from 10 to 55 cents a piece for the props, or an average of about 32 cents. It is estimated that $1,029,910 was spent for 3,182,940 props.

Over half (56.4 percent) of the total volume came from Illinois woodlands, and most of the rest from Missouri, with a very little coming from Wisconsin.

Posts or legs. Although similar to props, posts (or legs) are larger in diameter, are generally round, and are used in more permanent installations, particularly where two of them support a horizontal

piece called a bar. Only the larger mines bought posts for this specific use; most operators selected the larger props for this purpose.

Posts ranged from 6 feet to 9 feet in length. Tip diameters ranged from 4 inches to 9 inches.

Most of the 507,400 cu. ft. used was white oak. Total number of pieces was 273,700. Cost of these products totaled $129,260, or about 47 cents a piece. Prices ranged from 19 to 90 cents.

Slightly over half of the total volume was supplied by Illinois woodlands, and the rest was cut in Missouri (48.2 percent) and Indiana (0.3 percent).

Scotch blocks and sprags. These are thrust between the car wheels and the track to stop, slow down, or otherwise control the movement of underground mine cars. Sprags resemble a policeman's night stick, which is about 2 inches in diameter. Scotch blocks have a thick, wedge-shaped head fastened to a handle. A few mines planned to substitute steel pipe for wooden sprags.

Most of the estimated 1,900 cu. ft. bought for these two purposes was used in the form of Scotch blocks. Some mines bought squared material (about 5″x 5″- 12″) and finished their own products, while others bought ready-to-use forms. Tough woods, such as elm and sycamore, were usually specified.

The 16,030 pieces cost $2,470, averaging about 15 cents each. The price ranged from 9 to 25 cents a piece. All Scotch blocks and sprags were purchased locally.

Miscellaneous items. A number of miscellaneous wood products used regularly or occasionally are not included in this report because of the relatively insignificant volume required. Although their total volume may not be large, their importance to a mine operator may be great. For example, less than 5,000 bd. ft. each of poles and piling, car bumpers, and scale decking were probably required in 1948, although these products may have been essential for producing coal.

Wood-Coal Ratios

Table 7 shows the amount of hardwood used per ton of coal produced by Illinois mines in 1948. It is estimated that all mines in the state used 0.620 bd. ft. of sawed products and 0.078 cu. ft. of other products for each ton of coal mined. Although the practice of expressing the volume of such small round products as props in terms of board feet is considered unsound, some readers may desire such a conversion for comparative purposes. The ratio for all products, in terms of board feet, is estimated to be 1.087 bd. ft. This is somewhat

higher than the ratios expressed by Hall and Ingalls[5*] (0.860) and Miller[12*] (1.075). The ratio in terms of cubic feet is 0.181.

Use of the ratios for estimating wood consumption in future years will depend upon how closely the wood use and coal production data

Table 7. — Amount of Hardwood[a] Used per Ton of Coal Produced by Illinois Mines[b] in 1948

Mine class	Cross-ties	Bars	Wedges	Lumber	Caps and header-blocks	Tim-bers	Machine blocks	Lagging
Underground mines								
	bd. ft.	*bd. ft.*	*bd. ft.*	*bd. ft.*	*bd. ft.*	*bd. ft.*	*bd. ft.*	*bd. ft.*
1	.301	.122	.143	.085	.099	([c])	.008	.002
1A	.322	.247	.154	.039	.049	....	....	....
1B	.200	.088	.042	.048	.079	....	....	....
2	.234	.192	.022	.050	.001	....	....	....
3	.403	.055	.021	.061	.064	....	....	....
4	1.204	.113	.026	.264	.035	.139	....	....
5	1.948	.058	.036	.323	.044	.027	....	....
Subtotal	.353	.166	.121	.072	.069	.007	.003	.001
Strip mines								
1	.011	....	....	.013	....	.057	....	....
1A	.020	....	....	.002	....	.073	....	....
1B	.201	....	....	.072	....	.085	....	....
2	....	....	....	....	....	....	....	....
3	.001	....	....	.002	....	....	....	....
4	1.301	....	....	.196	....	....	....	....
5	1.469	....	....	1.914	....	1.144	....	....
Subtotal	.062	....	....	.025	....	.063	....	....
Total	**.275**	**.121**	**.088**	**.059**	**.050**	**.022**	**.002**	**.001**

Mine class	Shim boards	Car patching	Props	Posts, legs	Scotch blocks and sprags	Total all sawed products	Other prod-ucts
Underground mines							
	bd. ft.	*bd. ft.*	*cu. ft.*	*cu. ft.*	*cu. ft.*	*bd. ft.*	*cu. ft.*
1	....	....	.105	.022	T[d]	.760	.127
1A	....	....	.068[a]	.004	T[d]	.811	.072
1B	....	....	.093	.004	....	.457	.097
2	....	....	.079	....	....	.499	.079
3	....	....	.224	....	....	.604	.224
4	....	....	.182	.004	....	1.781	.186
5	....	....	.213	.013	....	2.436	.226
Subtotal	....	....	.096	.010	T[d]	.792	.107
Strip mines							
1	.002	....	....	....	....	.084	....
1A	....	....	....	....	....	.095	....
1B	....	....	....	....	....	.358	....
2	....	.008	....	....	....	.008	....
3	....	....	....	....	....	.002	....
4	....	....	....	....	....	1.497	....
5	....	....	....	....	....	4.527	....
Subtotal	.001	.002	....	....	....	.154	....
Total	**T[d]**	**.001**	**.070**	**.008**	**T[d]**	**.620**	**.078**

[a] Calculations include 6,220 cu. ft. of tamarack.
[b] Mines producing less than 1,000 tons in 1948 were not included.
[c] Blanks signify that none of the mines questioned in the specified class reported that they used any wood for the purpose indicated.
[d] T = trace, less than .001.

compare with those for 1948. It is reasonable to assume, however, that, in lieu of detailed information, ratios will serve as valuable guides for estimating the volume of wood consumed in any future year.

PRESERVATIVE TREATMENT OF WOOD

Use of Treated Wood in Mines

So far as the investigators know, all treated wood was purchased primarily for its resistance to decay, although reports of insect attack were received. None of the sample mines reported the purchase or use of lumber treated specifically for resistance to fire. Some, however, reported a preference for chromated zinc chloride as a preservative because they believed it offered greater fire protection than other commonly used chemicals.

Probably more of the wood purchased by the sample mines should have been treated against decay than actually was treated. It is estimated that, of the 40,985,400 bd. ft. of sawed hardwood products used in 1948 (Table 3), 3,414,510 bd. ft. or 8.3 percent (Table 8) were treated. None of the other products were treated. About 2,725,270 bd. ft. (80 percent) of the treated materials were purchased by underground mines. Of the total volume of treated products, 98.2 percent was in the form of crossties; 1.6 percent, lumber; and 0.2 percent, lagging. The mine operators spent an estimated $284,780 for treated hardwood products.

Table 8 shows that 86.9 percent of the wood used by Class 4 strip mines was treated and that this class used 1½ times as much treated wood as all other classes of strip mines combined. The reason is that Class 4 sample mines used an abnormally large supply of treated ties for permanent trackage that was installed in 1948. This abnormality is reflected in the percentage of treated wood used by all strip mines. However, the percentage of treated wood used by both underground and strip mines (8.3 percent) is little affected. It would have been decreased by only 1 percentage point even if the Class 4 mines had used no treated wood at all. Nor is the abnormality in the percentage of treated wood used by Class 4 mines reflected in estimates of volumes used, cost of materials, and source of supply.

The amount of treated softwood lumber used by the mines was not determined, but it probably did not exceed 5 percent of the total volume. Because of the low resistance of untreated pine and fir to decay and the environment in which these species were used, their service life was usually short and expensive. Much of the softwood lumber went into air shafts, air-control doors, and brattices, all of

Table 8. — Volume and Cost of Treated Wood[a] Used in 1948 by Illinois Coal Mines[b]

Mine class	Volume in board feet: All wood used	Volume in board feet: Wood treated with creosote	Volume in board feet: Wood treated with CZC[c]	Volume in board feet: Total treated wood	Percent treated wood is of total volume	Cost in dollars: All wood used	Cost in dollars: Wood treated with creosote	Cost in dollars: Wood treated with CZC[c]	Cost in dollars: Total treated wood	Percent treated wood is of total cost	Treated products: Name of product	Treated products: Percent of treated wood
Underground mines												
1	14 183 700	882 610	241 720	1 124 330	7.9	$1 331 020	$87 880	$24 070	$111 950	8.4	Ties	99.6
											Lagging	.4
1A	14 805 500	1 478 720	(d)	1 478 720	10.0	1 075 620	109 530	......	109 530	10.2	Ties	100
1B	2 288 100	115 160	....	115 160	5.0	224 300	10 010	......	10 010	4.5	Ties	100
2	1 166 800	....	....	....	....	95 380	......	......	......	....	Ties	100
3	810 900	....	....	....	....	83 380	......	......	......	....	......	....
4	4 226 200	....	....	....	....	269 110	......	......	......	....	......	....
5	748 200	7 060	....	7 060	.9	32 690	250	......	250	.8	Ties	100
Subtotal	38 229 200	2 483 550	241 720	2 725 270	7.1	$3 111 500	$207 670	$24 070	$231 740	7.4	Ties	99.8
											Lagging	.2
Strip mines												
1	726 700	86 730	....	86 730	11.9	$ 42 100	$8 670	......	$8 670	2.1	Lumber	78
											Ties	22
1A	531 600	61 240	....	61 240	11.5	39 520	5 570	......	5 570	1.4	Ties	100
1B	719 800	128 670	....	128 670	17.9	43 020	8 040	......	8 040	1.9	Ties	100
2	42 600	....	....	....	....	920	......	......	......	....	......	....
3	16 900	....	....	....	....	900	......	......	......	....	......	....
4	474 800	412 600	....	412 600	86.9[e]	30 880	30 760	......	30 760	99.6[e]	Ties	....
5	243 800	....	....	....	....	13 460	......	......	......	....	......	....
Subtotal	2 756 200	689 240	....	689 240	25.0[e]	$ 170 800	$ 53 040	......	$ 53 040	31.1[e]	Ties	90.1
											Lumber	9.9
Total	**40 985 400**	**3 172 790**	**241 720**	**3 414 510**	**8.3**	**$3 282 300**	**$260 710**	**$24 070**	**$284 780**	**8.7**	**Ties**	**98.2**
											Lumber	**1.6**
											Lagging	**.2**

[a] Pressure processes were used for all treated wood except that used by Class 5 underground mines, which was cold-soaked.
[b] Mines producing less than 1,000 tons in 1948 were not included.
[c] CZC = chromated zinc chloride.
[d] Blanks signify that none of the mines questioned in the specified class reported that they used wood treated with the indicated chemical.
[e] See discussion on page 527.

which were subject to early infection by fungi and to failure. Some permanent installations of square southern pine legs and bars were treated with CZC (chromated zinc chloride), but none of the hardwood legs and bars were treated.

Of the 2,725,270 bd. ft. of treated wood used by underground mines, 99.8 percent was in the form of crossties. All of them were treated with a 70-30 mixture of creosote and coal tar at the rate of 6 pounds per cubic foot. Only 0.2 percent of the total volume was treated lagging. CZC was used as a preservative, and the specified retention was ½ pound per cubic foot.

Of the total volume of treated wood used by strip mines, 90.1 percent was crossties, and the rest was heavy lumber. The crossties were generally purchased for use in standard-gauge rail lines linking the mines with common carriers.

Preservatives

About 93 percent of the total volume of treated wood was pressure-treated with creosote or a 70-30 mixture of creosote and coal tar. A few operators reported minimum retentions greater than 6 pounds per cubic foot for switch ties, but a minimum of 6 pounds was specified for crossties. Though not bought in 1948, some tipple piling and poles were in use that had been pressure-treated with 8- to 12-pound retentions of creosote or creosote-coal tar mixtures. Some of the mines reported that scale decking and support timbers and tipple siding and supporting members had been treated with creosote by pressure, brushing, or spraying.

Nearly all the rest of the hardwood was treated with CZC at the rate of ½ pound per cubic foot. Some of the pine legs and bars were also treated with this chemical at the rate of 1¾ pounds per cubic foot.

At least one company was using pentachlorophenol[a] to brush-treat coal-car bottoms. Two companies reported small-scale tests of Osmosar, a water-soluble preservative, containing a mixture of toxic chemicals.

Attitude of Mine Operators Toward Use of Treated Wood

Many of the operators were asked why they did not use more treated wood. The most frequent reply was, "It costs too much." Because of alleged high cost, treated materials were used primarily in main haulage ways, permanent air shafts, and other long-term installa-

[a] Since this study was completed, a few mines have purchased crossties, props, and bars treated with a 2½-percent solution of pentachlorophenol. Although recommendations specify concentrations of 5 percent, concentrations below this amount are often used to keep down costs.

tions — and then usually only in the mines of the larger companies. The smaller companies used untreated wood and specified white oak because its heartwood offers relatively greater resistance to decay.

Although a detailed study of the economics of using treated wood was not made, sufficient data were obtained on which to base an analysis. The average cost of treated wood used by the mines was $83 per thousand board feet (Table 8), and that of untreated about $50. Installation costs would be about the same for treated and untreated materials, but the average annual labor cost would decrease as service life lengthened. Thus, the use of treated timber would result in a schedule of decreasing labor costs.

Some of the operators estimated that they would be justified in using treated wood if the treatment doubled the service life of products. On the other hand, the reported life of treated wood in service was in every case more than double that of untreated wood, ranging from 10 to 20 years or longer. Untreated products rarely lasted 5 years, and they usually failed after only 2 or 3 years of service.

In a service test[4*] using maple timbers treated by the hot- and cold-bath method and installed in a Michigan iron mine, zinc chloride-treated timbers had an average useful life of 13.3 years; borax-treated timbers, 11.2 years; and sodium fluoride-treated timbers, 7.7 years. Untreated timbers used as controls had an average useful life of 3.8 years. In an example based on one company's installation costs and the useful life of the test timbers, the annual charges, using 5-percent interest rate, were estimated as follows:

	Cost per set[a] per year
Untreated timbers	$4.38
Treated timbers	
Sodium fluoride	3.02
Borax	2.23
Zinc chloride	1.97

([a] Two posts or legs and a cap or bar.)

In these tests, the estimated savings ranged from $2.41 to $1.36 per set each year. The investigators indicated that low absorptions of sodium fluoride and borax ". . . preclude using the results of this experiment as a basis for comparing the relative effectiveness of the three preservatives. It was felt, however, that sodium fluoride- and borax-treated timbers would last long enough to more than pay for the cost of the treatments, even though they did not represent the best results. This judgment was supported by the results of the service test."

The above figures indicate without a doubt the value of treated wood in long-term installations. Many operators conceded this value but questioned the use of treated wood for temporary installations. Obviously it is not economical either to place treated wood in temporary installations without salvaging it later, or to extend its potential service beyond that which may be received before the product fails from mechanical wear. Salvaging support timbers not only is hazardous but also may not be economical at present labor rates (page 533). However, many of the mine operators indicated that small roomties used on a temporary basis could be salvaged and reused several times before they failed from decay, mechanical wear, or spike killing.[a] Treatment of roomties therefore appears to be justified.

Service life of ties might be further extended, and the drain on the local timber resource reduced, by using square ties that could be turned 90 degrees and reused. For example, a 3″x 4″- 5′ tie contains 5 bd. ft. If the average length of service is two years (assuming decay is not the cause of failure), two of them containing 10 bd. ft. would last four years. On the other hand, a 4″x 4″- 5′ could be used two years on one side and then turned 90 degrees (one side becomes bottom) and used two more years. A 4″x 4″- 5′ contains 6.75 bd. ft., or about two-thirds the total board foot volume of two of the smaller ties. There would, however, be no cash saving if the manufacturer of the tie charged more for the tie with a 4″x 4″ cross section than two of the 3″x 4″ ties would cost. If the costs were the same, only wood would be conserved.

Another objection to the use of treated wood was the reluctance of workmen to handle creosoted material. The unpopularity of creosote was attributed to an oily, sticky coating on the wood, which frequently burned the skin of those handling it. Some miners also believe it creates a fire hazard in the mine or that the treated wood creates an additional hazard because it burns with a very dense smoke. Use of "clean-treatment" chemicals with fire-retardant qualities may be one means of eliminating these objections.

Home Treatment by Mine Operators

A few underground mines in almost every class reported some type of "home treatment." That is, they brushed, sprayed, dipped, or soaked wood for various installations. The total volume treated in

[a] Spike-killed ties are those which have been so decayed, checked, or split as a result of spiking that they will no longer hold the spikes.

this way, however, was small. None of the strip mines reported any kind of home treatment.

Because home treatment seemed to offer a number of advantages, it was suggested to a few operators who hadn't tried it. As already brought out, use of treated wood cuts labor and material costs in the long run, reduces maintenance, and decreases the drain on the local timber resource. Yet treated wood is often hard to get. Most of the mines bought their wood products locally, and local custom pressure-treating facilities were available in only a few areas. Treated products in the sizes used by individual mines were not always stocked by commercial treating companies (even when the size specified was of "common dimension"), although crossties of standard size were usually available.

A small semicommercial plant could probably be built for as little as $3,000 (1949 prices) that would allow the operator to treat timbers by the pressure, vacuum, hot-cold bath, or cold-soak method. (Of these methods, the pressure is the best and the cold-soak the least desirable.) To justify the investment enough wood would have to be treated to keep the plant in continuous operation. It might be possible for several mines to use the plant on a cooperative basis, thereby making full use of the facilities and also reducing the amount of their individual investment, the cost of treating, and the required number of operating personnel.

There are, however, disadvantages to home treatment. One of the biggest problems is that of labor. Most coal-mining operations are carried on by organized labor, and it would be almost impossible to initiate any new operation — such as the installation and operation of a treating plant — unless the work were included in the labor contract.

Removing the bark before treatment might involve another labor problem. Ordinarily, wood products are peeled on a piecework rate; however, organized labor might want this work to be included as part of the mining operation and done by members on a day-rate basis. Hand-peeling at day rates would not be economical. In some parts of Illinois, particularly the southern part, it might be possible for the operators to buy products peeled by the producer. If the volume of wood involved were large enough, peeling machines could be installed by the mines.

If labor contracts insisted that peeling, seasoning, and treating be done at standard rate of pay for mine labor, it is doubtful whether the mines could do their own treating economically enough to justify the installation.

Other disadvantages of home treatment are that it may increase problems of space and inventory, since a large amount of wood is ordinarily stored for air seasoning before treatment.

RECLAMATION OF TIMBER

The salvaging of mine timbers for reuse depends upon a number of factors, among which the most important are (1) the safety of the salvage workers, (2) the cost of labor involved, and (3) the cost and scarcity of timber supplies. Although these three factors are generally considered in the order in which they are listed, their relative significance varies for each mine. For example, it might be safe in some mines, or within certain areas of a single mine, to salvage timbers, and therefore the mine superintendent would base his decision on the second and third factors only.

Some timber was salvaged for reuse in many mines in 1948. Within each of the production classes, reports by representative mines ranged from "nothing salvaged" to 100-percent salvage of certain products. A proportionately larger number of underground mines than of strip mines reported salvage of timber. Mat timbers and ties are about the only items one could expect to be salvaged in strip mines. Since most of the ties were treated, their potential service life was probably fulfilled before replacement. Salvaging one or two timbers from a mat which has served its useful life would probably not be economical. Therefore, the opportunities for salvaging timber are considerably fewer at a strip mine than at an underground mine.

Crossties, particularly roomties, were salvaged in greater quantities than any other item. The operation of temporary trackage lends itself to tie salvage, and there is little danger involved in reclaiming crossties. Small mines reused ties from one to five times, or until they failed from decay or mechanical wear. On the other hand, props, posts, bars, and supporting timbers are difficult to salvage with any measure of safety to personnel, and the cost of salvaging at high wage rates is not economical. As one operator said, "Props cost less than I have to pay to have them salvaged."

Treated materials were generally salvaged for reuse because of their greater cost and longer potential service life. Permanent timbers, of course, served until they failed or were declared unsafe. Salvage operations were therefore confined to temporary installations.

It appears that more timber could be saved through salvage, but definite conclusions cannot be drawn until more is known about each of the three factors presented in the first paragraph of this section.

STANDARDIZATION OF MINE TIMBER SIZES

Analysis of the data provided by the cooperating mine operators indicates that some standardization in sizes of various mine timbers would be beneficial. The mine operator's primary objection to standardization would probably be that each mine presents a different set of operating conditions. There would be little merit to advocating any standard prop length unless it could be used by each mine. On the other hand, there appears to be no sound basis for 91 mines buying over 40 different sizes of crossties. Some mill operators cut as many as four different sizes of crossties, and each tie differed from the others by only a fraction of an inch. For example, the following lengths of 3″x 4″ ties were reported: 38, 44, 48, 54, 56, and 60 inches. In addition, there were 2″x 4″, 2½″x 4″, 2½″x 4½″, 3″x 3″, 4″x 4″, and 3½″x 5½″ sizes ranging in length from 42 to 66 inches. Certainly the time of the sawmill operator as well as the wood, could be conserved by reducing the number of sizes of motorties and roomties. Another advantage of standardizing the sizes of these products is that it would be possible for mill operators to retail ready-treated ties. At present, with the many different sizes that are specified, the cost of carrying an inventory of treated ties is too great.

Caps, wedges, headerblocks, machine blocks, and sprags are other products that could probably be standardized in size.

WOOD PROCUREMENT AND SUPPLIES

Methods of Procurement

Most mines had one or more suppliers upon whom they depended for timber. As a rule, they bought from jobbers[a] or producers. Although producers cut most of the Illinois wood that was used, a small number of products were cut and delivered by farmers. A few of the very small mines cut their own wood products, usually from their own lands. Some of the larger mines employed a timber buyer who negotiated all purchases and checked on inventories and deliveries.

Products cut in Illinois were delivered in truckload quantities, and many shipments from out of the state were made by truck also. Most of the carload deliveries came from Missouri. One mine reported at least a single carload shipment from Wisconsin.

[a] Jobbers acted as wholesalers or concentrators of timber products, buying from one or more producers and reselling to the mine. Some of the jobbers also produced timber products.

At least one mine owned a small sawmill (Fig. 17), which was used to cut small bolts into caps, wedges, roomties, and brattice lumber. The bolts were purchased by weight from farmers and timber producers.

This small, mine-owned sawmill is cutting a white oak bolt into caps, wedges, roomties, and brattice lumber. Bolts were purchased by weight, averaging 51 cents each at 26 cents per 100 pounds. They ranged from 6 to 14 inches in diameter and were 4 to 8 feet long. (Fig. 17)

Effect on Local Woodlands

Heavy demands for mine timbers in many areas have resulted in heavy overcutting of local timber stands — particularly the young second-growth. Props can be cut from trees as small as 4 inches d.b.h.[a], and posts or bars from trees approximately 8 inches d.b.h. The practice of cutting props, posts, and bars from small trees is unfortunately prevalent in Illinois. Piece-rate cutters, who probably produce most of the mine timbers, can "make" props, posts, and bars from small trees more profitably than from large trees, most of which must be split into smaller sizes. Because time means money to the piece-rate cutter, clear-cutting is favored over the more conservative system of selecting trees for removal from the forest.

[a] D.b.h. refers to diameter at breast height, or 4½ feet above average ground level.

This woodland has been heavily cut for mine props and ties. It will be many years before the area will again yield a crop of wood products. The cost of improving the area for pasture would be considerable. (Fig. 18)

Trees from 4 to 8 inches d.b.h. represent the majority of stems in second-growth forests, which include all but an insignificant amount of Illinois' woodlands. Second-growth forests require some carefully planned thinning of sapling and pole stands. However, continued over-cutting of the smaller sizes means that crop trees are taken before they have grown to full size and full value.

The present situation of Illinois woodlands therefore gives cause for concern. However, as brought out in the following pages, supplies are still adequate, and if proper steps are taken, will continue to be so.

Present Supply Situation

Most of the mine operators reported that supplies in 1948 were "adequate" or "plentiful," and a few indicated that their main problem was preventing an over-inventory. None of the operators reported the supply situation to be critical, although a few of the larger operators reported that they bought certain timbers in Missouri because the supply of white oak was better, a price was more favorable, or it was less trouble to get delivery on large orders.

A year earlier, however, woods labor was still hard to get, and the problem of supply was more critical. Buyers were often forced to create an over-inventory to carry them through periods when supplies were not available or deliveries were tardy.

FUTURE REQUIREMENTS AND SUPPLIES

Trends in Use of Wood Products

Future wood requirements of the mining industry and the effect of its drain on the state's timber resource will depend largely upon the answers to these two questions: (1) Will satisfactory substitute materials and methods be developed? (2) Will the current demand for coal be maintained?

Because of their fireproof qualities, building tile, concrete and cinder blocks, and brick have largely replaced wood for use in brattice and for sealing off old galleries. Steel has replaced wood for mine cars (Fig. 19) in many mines, and for crossties in a few mines.

Attempts are also continually being made to replace wood with something better in other places. For example, steel railroad rails have been used to replace wooden cross bars in some mines, and roof bolts (Fig. 15) are used where conditions warrant their use.

Roof bolting, or suspension support, has the advantage of supporting the wide openings of mechanized workings without hindrance to machine maneuverability and ventilation. However, the use of metal roof bolts has been found to present a problem. While a wooden prop "squeaks" under loads that tend to exceed its compressive

Although steel has replaced wood in the construction of these mine cars, they are carrying wooden props for mine roof supports and they are traveling on rails which are supported on wooden crossties. (Fig. 19)

strength and thereby warns the workers, a metal roof bolt may fail without warning. But there is no reason why wood cannot be used in roof bolting. Some advantages of the use of wood in suspension support have been found in experimental work by the Department of Mining and Metallurgical Engineering, University of Illinois, and other successful use has also been reported.[10*, 11*]

Other metal supports of different types have been designed, tried, and abandoned. Mine operators therefore still believe that wood is the best supporting material they can use, considering service, economy, and supply factors. Thus, the trend toward continued use of wood for support timbers is strong and is likely to grow stronger if government controls restrict the use of certain metals and if the markets for Illinois coal are expanded.

Illinois Woodlands as Future Source of Timber Supplies

Since the first coal mine was operated, Illinois mine operators have depended upon local woodlands for a considerable portion of their mine timbers. Some operators question whether this practice can continue. For the past 50 years there have been reports of a "steadily decreasing" timber supply in Illinois, and there must have been some basis for them.

It is true, for example, that certain species, such as white oak and other naturally durable woods, particularly the better grades, are in short supply. It is also true that timberlands in general have been cut, grazed, and burned to the point where they are not so extensive as they once were or not so productive as they should be (page 535). However, current data based on reliable, up-to-date information[3*] are now available which give a little brighter view of the situation.

Some of these data are given in Fig. 20 and Tables 9 and 10. In Fig. 20 the state is divided into three regions: southern, claypan, and prairie. The proportion of each county that is forested is shown. Table 9 lists those counties in each of the three regions for which operating mines were reported in 1948,[8*] the number of mines in these counties, and the total county coal production and forest acreage.

The most coal is produced in the southern region. This area includes counties having a high percentage of woodland. Twenty-six percent of this area is forest land, whereas only 16 and 7 percent of the claypan and prairie regions, respectively, are forested. However, the actual acreages of forest land are greater in the claypan and prairie regions than in the southern region.

Table 10 represents a "balance sheet" for 1948. It shows the esti-

mated amount of wood grown in the three regions and the volume required for use by the coal mines (based on coal production). It is true that not all the hardwood used in 1948 by the coal mining industry came from Illinois (Table 5), but in analyzing our future requirements let us assume that Illinois woodlands are to supply the industry's

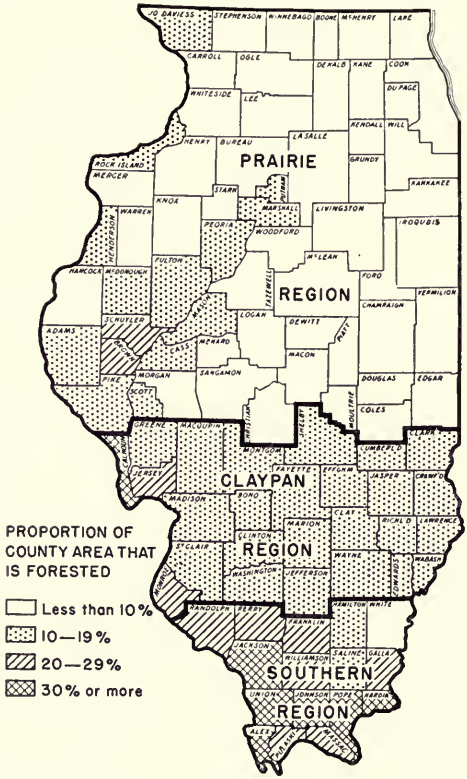
Table 9. — Number of Mines, Coal Production, and Forest Acreage, by County, for Three Illinois Regions[a]
(Only counties having coal mines are included)

Region and county	Number of mines[b]			1948 coal production[b]	Forest acreage[c]	
	Shipping	Local	Total		Thousand acres	Percent of total land area
Southern region				*tons*		
Franklin	12	..	12	13 310 042	62	22
Gallatin	1	10	11	76 076	55	26
Jackson	5	5	10	1 241 423	123	32
Perry	9	3	12	5 227 860	61	22
Randolph	5	3	8	2 500 002	85	22
Saline	12	9	21	4 454 175	43	18
Williamson	44	28	72	4 861 424	60	21
Total	**88**	**58**	**146**	**31 671 002**	**489**	..
Claypan region						
Clinton	2	..	2	296 147	62	19
Jefferson	1	..	1	570 676	61	17
Jersey	..	1	1	T[d]	66	28
Macoupin	9	..	9	4 281 292	95	17
Madison	4	6	10	2 091 468	57	12
Marion	1	..	1	238 667	62	17
Montgomery	1	..	1	925 221	46	10
St. Clair	14	12	26	3 097 385	55	13
Washington	2	2	4	495 141	63	17
Total	**34**	**21**	**55**	**11 995 997**	**567**	..
Prairie region						
Brown	..	2	2	T[d]	42	21
Bureau	1	..	1	99 127	35	6
Christian	5	1	6	7 918 145	13	3
Douglas	1	..	1	114 311	5	2
Edgar	..	1	1	21 377	23	6
Fulton	12	14	26	6 488 523	96	17
Grundy	1	2	3	170 739	10	4
Hancock	..	1	1	47 077	46	9
Henry	2	4	6	706 311	17	3
Knox	3	1	4	1 474 214	44	9
LaSalle	2	6	8	141 685	26	4
Livingston	..	2	2	5 255	9	1
Logan	..	1	1	49 528	11	3
McDonough	..	4	4	T[d]	40	11
Marshall	..	1	1	T[d]	28	11
Menard	..	5	5	27 362	15	8
Morgan	..	1	1	T[d]	30	8
Peoria	1	26	27	684 659	52	13
Rock Island	..	1	1	T[d]	34	13
Sangamon	4	6	10	2 219 443	24	4
Schuyler	1	11	12	145 572	69	25
Tazewell	..	2	2	78 899	38	9
Vermilion	2	18	20	411 503	29	5
Warren	..	1	1	2 292	25	7
Will	2	..	2	1 664 282	23	4
Woodford	1	..	1	13 658	30	9
Total	**38**	**111**	**149**	**22 483 962**	**814**	..

[a] Regions outlined in Fig. 20.
[b] From Sixty-Seventh Coal Report of Illinois. Ill. Dept. of Mines and Minerals, 1948.
[c] Data supplied by Central States Forest Experiment Station, Columbus, Ohio.
[d] T = trace, or less than 1,000 tons.

entire needs. Any contributions to the requirements made by other states will of course help to alleviate the drain on Illinois timberlands.

Perhaps the most significant figures in Table 10 are those which show the percent of annual growth used for mine timbers. Twelve



Location of forest survey regions in Illinois, and the proportion of area of each county that is forested. (Fig. 20)

percent of all wood grown in the state was used by coal mines. The range was from 7 percent in the claypan region to 20 percent in the southern region.

In analyzing the data shown in Table 10, a number of factors must be taken into consideration. For one thing, it must be remembered that the growth figures represent all types of timberlands and all sizes and kinds of trees. In some areas much of the woodland is found along the bottomlands of streams and rivers, and the species are usually not the ones preferred by the industry. Growth in some areas and on some soil types is slow, and locally the drain may exceed the supply.

Table 10. — Relation Between Wood Growth in Three Illinois Regions[a] and Total Wood Consumption by Coal Mines in 1948

	Southern region	Claypan region	Prairie region	Total
Total forest acreage	1 042 000	1 356 000	1 598 000	3 996 000
Forest acreage—counties with mines[b]	489 000	567 000	814 000	1 870 000
Total wood growth per year, cubic feet[c]	28 299 000	30 732 000	33 711 000	92 742 000[d]
Coal production, tons[b]	31 671 000	11 996 000	22 484 000	66 151 000
Wood consumption, cubic feet[e]	5 732 400	2 171 300	4 069 600	11 973 300
Wood consumption, percent of annual growth	20	7	12	12

[a] Regions outlined in Fig. 20.
[b] Data from Table 9.
[c] Data supplied by Central States Forest Experiment Station, Columbus, Ohio.
[d] Includes 311,000 cubic feet of softwoods.
[e] Wood-coal ratio of 0.181 cubic foot per ton of coal produced, used to calculate consumption.

Cost of hauling timbers is another factor. There is an economic limit to the distance that mine timbers can be hauled by truck; beyond this distance rail shipments may be more economical. Also, the wood used by other industries must be considered. Sawmills, veneer plants, cooperage mills, charcoal manufacturers, pulpwood buyers, and miscellaneous consumers of hardwoods, as well as the coal mines, draw upon the forest supply.

A recent study by the Central States Forest Experiment Station of all factors influencing the state's timber resources indicated that present annual growth is more than twice the present drain. In addition to the hardwood timberlands, several thousand acres of private and public lands have been reforested with pines and other softwoods, which usually grow faster than the hardwoods.

About 1,200 pine seedlings are planted on the average acre. Then, when the trees are of prop size, or 10 to 20 years old, thinning must begin. About 1,000, or 83 percent, of the trees are eventually removed as thinnings, since the land will support only about 200 crop trees of sawlog size. Each acre is therefore a potential producer of thousands of props, posts, bars, and ties.

Although pines are generally considered to be nondurable in contact with soil, they are used as mine timbers in other areas and are as durable as some of the hardwood species now accepted for use in Illinois mines.

Thus timber requirements of the coal-mining industry should be supplied with less difficulty in the future than they have in the past. The more extensive use of wood preservatives, salvage operations (where safe, economical, and practical), and species not now accepted will help to improve the future supply.

Use of Substitute Species

Because of the great demand among mine operators for white oak, this species is in short supply in some areas. The same thing is true of some other naturally durable species. This leads us to explore the possibilities of other species not now being used.

Table 11. — Maximum Crushing Strength Parallel to Grain and Modulus of Elasticity for Illinois Woods in Green Condition[a]

Species	Maximum crushing strength (p.s.i.[b])	Modulus of elasticity (1,000 p.s.i.[b])	Species	Maximum crushing strength (p.s.i.[b])	Modulus of elasticity (1,000 p.s.i.[b])
Hardwoods			*Hardwoods*		
Apple	3 000	1 050	Oak, pin	3 680	1 320
Ash, blue	4 180	1 240	Oak, post	3 480	1 090
Ash, green	4 200	1 400	Oak, scarlet	4 090	1 480
Ash, white	3 990	1 460	Oak, southern red	3 030	1 140
Beech	3 550	1 380	Oak, swamp chestnut	3 540	1 350
Cherry, black	3 540	1 310	Oak, swamp white	4 360	1 590
Dogwood	3 640	1 180	Oak, water	3 740	1 550
Elm, red	3 320	1 230	Oak, white	3 560	1 250
Elm, rock	3 780	1 190	Oak, willow	3 000	1 290
Gum, black	3 040	1 030	Osage orange	5 810	1 330
Gum, tupelo	3 370	1 050	Pecan	3 990	1 370
Hickory, bitternut	4 570	1 400	Persimmon	4 170	1 370
Hickory, mockernut	4 480	1 570	Walnut, black	4 300	1 420
Hickory, pignut	4 810	1 650			
Hickory, shagbark	4 580	1 570	*Softwoods*		
Honeylocust	4 420	1 290			
Hophornbeam	3 570	1 150	Cedar, eastern red	3 570	650
Locust, black	6 800	1 850	Cypress	3 580	1 180
Maple, sugar	4 020	1 550	Pine, loblolly	3 490	1 410
Oak, black	3 470	1 180	Pine, Norway (red)	3 080	1 380
Oak, bur	3 290	880	Pine, shortleaf	3 430	1 390
Oak, northern red	3 440	1 350	Tamarack	3 480	1 240

[a] From *Strength and Related Properties of Woods Grown in the United States*, by L. J. Markwart and T. R. C. Wilson. U. S. Dept. Agr. Tech. Bul. 479. 1935. Table 1.
[b] Pounds per square inch.

In considering substitutes for white oak, it must be remembered that its relatively great durability applies only to the heartwood.[a] The outer band of sapwood[a] of most native species has low resistance to decay. For example, a round white oak prop with a 4-inch tip may have a heartwood diameter of 2½ inches or less; thus the strength will be reduced considerably when the sapwood decays.

In Table 11 are listed a number of woods found in this state that should prove satisfactory for props in Illinois mines. As shown in the table, all these woods have a maximum compressive strength parallel

[a] Heartwood is the wood extending from the pith (center) of the tree to the sapwood, which lies just under the bark. Heartwood is usually darker in color, more resistant to decay, and harder to penetrate with wood preservative than is sapwood.

to the grain (strength as a post or prop) of at least 3,000 p.s.i.[a] This strength requirement has been set arbitrarily, but it is believed that green wood meeting the requirement would serve satisfactorily as props or posts as far as compressive strength is concerned.

Another test of the suitability of a species is the modulus of elasticity. This measures the stiffness of the wood. Operators selecting short[b] props or posts need not be concerned with this measure, but it is important in determining the load that intermediate and long props can carry. Since most of the props used in Illinois mines are intermediate,[b] the modulus of elasticity has been included in Table 11, so that operators who have determined their minimum requirements may calculate the capacity of a prop for supporting a load. (It is believed, however, that all woods in the table will have enough stiffness to serve as props in Illinois mines.)

A number of other factors besides compressive strength and stiffness bear upon the suitability of a particular species for support timbers. Moisture content, freedom from weakening defects, strength as a beam (modulus of rupture)[c], and resistance to insects and decay (Appendix I) are highly important. Seasoning the wood below its fiber saturation point[d] before installing it would tend to increase its strength, but the moisture from the humid air in an underground mine would return it almost to its green strength. At present, the quality of a prop or its freedom from weakening defects is determined solely by visual inspection and its selection is based mainly upon experience. Apparently this method of selecting props has proven satisfactory.

If the wood lacks resistance to decay and insects, the possibility of chemical treatment should be considered (pages 527 to 533). Appendix II presents suggested specifications for use in Illinois mines. These specifications are based upon the experiences of Illinois mine operators

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[a] Pounds per square inch.

[b] Props or posts are classed as "short," "intermediate," or "long," depending upon the ratio of their unsupported length to least cross-sectional dimension. Short props are those whose length is less than 11 times their least diameter. Intermediate props are those in which the ratio of length to diameter may range from 11 to that at which the allowable stress per unit area is two-thirds that of the short prop of the same species of wood. For a complete discussion of the mechanical properties of wood see *The Mechanical Properties of Wood,* by F. F. Wangaard, John Wiley and Sons, New York, 1950.

[c] Values for modulus of rupture required for calculating the strength of bars or beams may be found in the publication referred to in footnote a, Table 11.

[d] Fiber saturation point represents the seasoning stage at which the cell walls of the wood are saturated, but the cell cavities are free of water.

and the treating practices developed by the American Wood-Preservers' Association.[a]

Of the woods listed in Table 11, tupelo gum is particularly extensive in the bottomlands of southern Illinois. Hickory is also plentiful in some areas. Norway (red), shortleaf, and loblolly pines, eastern red cedar, and tamarack are softwoods which meet the strength requirements and which occur naturally or in plantations in various parts of the state.

Other woods which are only slightly below the strength requirement might be acceptable as props if tip diameter were increased slightly. These include sycamore, with a compressive strength of 2,920 p.s.i., and American or white elm, with a strength of 2,910. Both of these woods are moderately stiff, having moduli of elasticity of 1,060,000 p.s.i. and 1,110,000 p.s.i., respectively. River birch is another wood which occurs plentifully in some areas. Although it has a maximum crushing strength of 3,510 p.s.i. it was not included in the table because its modulus of elasticity has not been determined. However, it possesses mechanical properties which should make it suitable for mine props.

Farmer's Role in Supplying Timber

Farmers own 90 percent of the woodlands in Illinois. Their future policies will therefore have a great deal to do with future supplies of timber.

As already mentioned (page 535), most of the wood is now cut by piece-rate cutters, who favor clear-cutting over selecting trees for removal, and who often cut trees before they have reached full size. This premature harvest of the wood crop is — to the farmer — similar to selling light-weight, unfinished beef cattle for slaughter.

At present neither the mine operator nor the landowner has much control over the producer. The landowner, however, is in a better position to initiate controls than is the mine operator. The problem of growing a continuous supply of mine timbers thus becomes his problem.

Management and harvest. If the woodland owner is interested in growing a profitable crop of quality wood that rates high in mechanical properties (strength and toughness), as quickly as he can, he should protect it from fire and grazing livestock and maintain

[a] The association is formulating a set of standards for treating mine materials which will probably appear in their *Manual of Recommended Practice.* The specifications in Appendix II are suggested for use until the final recommendations are published.

thrifty growth through proper thinning.[a] Thinning operations must be balanced, however, so that a rather dense stand is maintained to encourage natural pruning of the limbs and the development of long, clear trunks. Proper treatment of the woodland will assure a crop of wood that rates high in strength which is of particular importance to the mine operator.

One good way for the farmer to insure that his woodland is managed properly is to harvest the crop himself. Sale of timber "on the stump" is generally considered to be the poorest method of marketing the wood crop. Rarely does the farmer sell his corn standing on the stalk in the field. Instead, he harvests it before marketing it and thereby sells his labor for growing and harvesting the crop. If he marketed his wood in the same way, he would not only have more control over how his woodland is cut, but would also have more return from it.

Concentration yards help in marketing. One difficulty that a farmer often encounters when he harvests his own crop is that volume may be too small for quantity sales. The large mines reported that they occasionally bought timbers from farmers in 1948 but were unable to depend on this source of supply. Their main objection was that farmers were unable to provide a sustained supply of timbers during the entire year.

The "concentration yard," which serves in the lumber business much as an elevator serves in the grain business, helps to take care of this problem. It allows the small producer to market small quantities of wood products. These products are then accumulated and sold in quantity — and often by grade or quality — to the larger consumers.

Some jobbers act as concentrators of mine materials in southern Illinois, either buying timber on the stump and having it cut, or buying small lots from many cutters. However, there are so few markets of this type in the state that outlets for small amounts of timber products are often limited.

The organization of concentration yards, or group marketing of another type, would aid both the small producer and the mine operator. To be satisfactory from the viewpoint of the mine operator the system would, however, have to assure him a sustained supply of mine timbers delivered on a definite schedule. The opportunity is there, but to assure satisfactory service to the consumer enough capital

[a] Residents of Illinois may get help with woodland management and reforestation problems from the nearest district forester; from the State Division of Forestry, Department of Conservation, Springfield; or the Department of Forestry, University of Illinois, Urbana.

would be necessary to permit stockpiling a rather large inventory. The relatively large amount of money required to finance concentration yards is probably one of the main reasons they are not more numerous.

SUMMARY

The Illinois coal-mining industry requires wood in many forms. To date no satisfactory economical substitute has been developed for many of these requirements.

Ninety-one mines supplied data concerning their 1948 hardwood requirements for this study. A total estimated volume of 40,985,400 board feet of sawed products and 5,158,100 cubic feet of other products was used by Illinois mines during the base year. This amounted to 0.620 board feet of sawed products and 0.078 cubic feet of other products for each ton of coal produced. Total consumption per ton of coal was 0.181 cubic feet or 1.087 board feet. Mine operators spent an estimated $3,282,300 for these products, averaging about $52 per thousand board feet and 23 cents a cubic foot. Underground mines spent 95 percent of this total.

Illinois woodlands supplied 69 percent of the total volume of sawed products and 55.8 percent of the others. Indiana and Wisconsin forests supplied only small amounts (0.1 percent or less), and Missouri supplied the rest. Most of the wood was oak.

About 8 percent of the sawed products, but none of the other products, were treated. Over 98 percent of the treated wood was crossties. A total of $260,710 was spent for treated wood. Practically all the wood was pressure-treated, 93 percent of it being treated with creosote or mixtures of creosote and coal tar, and the rest with chromated zinc chloride.

Some timber was salvaged for reuse, although no data were available on which to base an estimate of the amount. Salvaging depended upon the safety of the salvage workers, cost of labor involved, and cost and scarcity of timber supplies.

For the industry as a whole, no attempt has been made to standardize products. In some instances (outstanding example is crossties, of which 40-odd sizes were reported), standardization would be beneficial to producer, consumer, and wood preserver.

Most of the products were purchased from jobbers or "middle men" and not directly from the woodland owner. Procurement practices have a deleterious effect on both productivity and earning power of the woodland resource.

The supply situation is good, and it appears that future timber supplies will be adequate to meet the demand. There is a current trend to replace timber supports in underground mines with metal or other substitutes, but these substitutes are not yet offering serious competition.

The practice of selling timber "on the stump" by the farmer (who owns about 90 percent of the woodlands) is not so profitable as selling products which he has harvested. However, the market often demands greater quantities than the individual woodland owner is able to produce, and the mining industry must be assured of a sustained supply. Group marketing or concentration yards are suggested as a means of improving marketing methods and farm income.

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APPENDIX I

Relative Durability of the Heartwood of Some of the Common Timbers of the United States With Respect to Fungi[a]

(Listed alphabetically and not in the order of their relative durability within a class)

Class I. Heartwood Very Durable, Even Under Conditions Favoring Decay

Softwoods	*Hardwoods*
Bald cypress	Black locust
Cedar	Black walnut
Alaska yellow	Catalpa
Eastern red	Chestnut
Northern white	Osage-orange
Port Orford	Red mulberry
Southern white	
Western red	
Redwood	
Yew	

Class II. Heartwood Durable, in Some Cases Nearly as Durable as That of Species in Class I

Softwoods	*Hardwoods*
Douglas fir (dense)	Honey-locust
Pine, southern yellow[b] (dense)	White oak

Class III. Heartwood Intermediate in Durability

Softwoods	*Hardwoods*
Douglas fir (unselected)	Chestnut oak
Pine, southern yellow[b] (unselected)	Red-gum
Tamarack	
Western larch	

Class IV. Heartwood Intermediate in Durability Between Classes III and V

Softwoods	*Hardwoods*
Hemlock	Ash, white (commercial)
Eastern	Beech
Western	Birch
Pine, lodgepole	Black
Spruce	Yellow
Black	Red oak
Engelmann	Sugar maple
Red	Sycamore
Sitka	Yellow-poplar
White	

Class V. Heartwood Low in Durability

Softwoods	*Hardwoods*
Firs (true)	Aspen
	Basswood
	Cottonwood
	Gum
	Black
	Tupelo
	Willows

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[a] From *Textbook of Wood Technology,* Vol. I, by Brown, Panshin, and Forsaith, McGraw-Hill Book Company, New York, 1949, Table 17. (As adapted from material in *Wood Handbook,* Forest Products Laboratory, U. S. Department of Agriculture, 1935; and *Wood Preservation,* by Hunt and Garratt, 1938.)

[b] Includes shortleaf, loblolly, and longleaf pines. There are no adequate records to evaluate the decay resistance of the heartwood of white pines and ponderosa pine, though it is believed that on the whole the heartwood of white pines is more durable.

APPENDIX II

Recommended Net Final Retentions of Various Preservatives for Wood Used in Mines[a]

(SPECIFIC REQUIREMENTS: Wooden mine materials shall be treated in accordance with the requirements of American Wood-Preservers' Association Standard C 1 "Standard Specification for the Preservative Treatment by Pressure Processes — All Timber Products," except as modified or supplemented by the following table.)

Preservative	Minimum retention (pounds per cubic foot) for—			
	Douglas fir	Southern pine	Mixed hardwoods[b]	Oak
When used for bars, buntons, capboards, cribbing, guides, lagging, legs, posts, props, shaft framing and lining, stairways, tipples, and trestles				
Chromated zinc chloride	.75	.75	.75	.75
Copper naphthenate-petroleum[c]	8	8	8	6
Creosote	8	8	8	6
Pentachlorophenol-petroleum[d]	8	8	8	6
Tanalith	.35	.35	.35	.35
When used for crossties and switch ties				
Copper naphthenate-petroleum[c]	8	8	8	6
Creosote	8	8	8	6
Pentachlorophenol-petroleum[d]	8	8	8	6
Tanalith	.35	.35	.35	.35
When used for piles				
Creosote	10	12	10	10
When used for poles				
Copper naphthenate-petroleum[c]	8	8	8	8
Creosote	8	8	8	8
Pentachlorophenol-petroleum[d]	8	8	8	8

[a] Recommendations in this table are tentative and are to be superseded by standard practices of the American Wood-Preservers' Association, 111 West Washington Street, Chicago 2, Illinois, whenever they are adopted.
[b] Excluding oak.
[c] 0.5-percent (copper metal) solution.
[d] 5-percent (by weight) solution.

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MINING COMPANIES COOPERATING IN STUDY

B & W Coal Company
Barr Coal Company
*Bell and Zoller Coal and Mining Company
Beveridge Coal Company
Big Bear Coal Company
Big Hollow Coal Company
*Blue Bird Coal Company
Blue Blaze Coal Company
Blue Ribbon Coal Company
Brooks Coal Company
Buckheart Creek Coal Company
Cantrall Coal Company
Carterville Blue Blaze Coal Company
Cedar Hill Coal Company
Central Coal Company
Cessna Bros. Coal Company
*Chicago, Wilmington and Franklin Coal Company
Clinton County Mining Company, Inc.
Collins Bros. Coal Company
Corbin Coal Company
Corder and Corder (Choate) Coal Company
Coulter and McKenna
*Crown Coal Company
David E. Rowland Triple S. Mine
Deep Valley Coal Company
Eddy Coal Company
*Elm Grove Coal Company
Elm Hill Mine
Franklin County Coal Corporation
Freeman Coal Mining Corporation
Harry Becker Coal Company
Helm Coal Company
Hoffman Coal Company
Kedas Coal Mine
Key Coal Company
Knight and Turner Coal Company
Lemon and McKelvey Coal Company
Midland Electric Coal Corporation
Midwest-Radiant Fuel Corporation
Moffat Coal Company
Morgan Mines, Incorporated
Morris Coal and Mining Company
New National Coal Mining Company
Northern Illinois Coal Corporation
Northwestern Illinois Coal Company
*Old Ben Coal Corporation
Panther Creek Mines, Incorporated
*Peabody Coal Company
Pekin Coal Company
Pekin Coal Mining Company
Pinckneyville Mining Company
Pine Bluff Coal Company
Polinski Coal Company
Prairie State Coal and Mining Company
Pyramid Coal Corporation
Ragenhardt and Southern
Ritter Coal Company
Rock Island Improvement Corporation
Schull and Moake Coal Company
Senior Hill Coal Company
Seymour Coal Mining Corporation
Sims Coal Company
Southwestern Illinois Coal Corporation
Stricklin-Gibbs Corporation
Strobel Coal Company
Sunny Brook Coal Company
*Superior Coal Company
The Pioneer Coal Company
*Truax-Traer Coal Company
Truck Trade Coal Company
*United Electric Coal Company
Valier Coal Company
V-Day Coal Company
Wasson Coal Company
Wildwood Coal Company

* More than one mine supplied data for this study.